

Regional Airport System Planning Analysis

2011 Update



Volume 3: Technical Reports

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Prepared for the **Regional Airport Planning Committee**



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Forecast Demand Allocation Methodology

June 2010

Prepared for
Metropolitan Transportation Commission
Regional Airport System Plan Analysis Phase 2

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Introduction

In order to analyze forecast future traffic levels at individual airports in the San Francisco Bay Area and the surrounding region as part of Phase 2 of the current Regional Airport System Plan Analysis update, it was necessary to define a methodology to allocate the forecast regional demand to each airport in the system and, in the case of system development scenarios involving diversion of air travel to high-speed rail, to high-speed rail stations. This technical memorandum documents the demand allocation methodology adopted and presents the resulting demand allocation for 2007, 2020 and 2035 for the Baseline and system development scenarios defined for the Target Analysis undertaken as part of the mid-point scenario screening in the study.

Although 2007 is considered the base year for both the demand forecasts and demand allocation and the actual airport passenger traffic counts are available for 2007, assigning those passenger trips to regional analysis zones requires the application of the demand allocation methodology because survey data on the distribution of the ground origins of air passenger trips is only available for earlier years, as discussed below. For this reason, even the base case distribution of regional air passenger trip ends is considered a demand allocation.

The allocation of forecast demand to airports and high-speed rail stations involved two steps: (1) distributing the actual or forecast total regional air passenger traffic to analysis zones; and (2) the allocation of the air passenger trips from each zone to the regional airports or stations. In order to keep the distinction between these two processes clear in the following discussion, the first steps is referred to as *assigning* the regional demand to analysis zones while the second step is referred to as *allocating* the resulting zonal demand to airports or rail stations. It should be noted that both steps involve assumptions, since there is only limited data on the past distribution of the ground origins of air passenger trips.

The primary purpose of assigning air passenger demand to regional analysis zones and then allocating the air passenger trips from each zone to airports and rail stations is to estimate the number of ground access and egress trips and the associated vehicle-miles of travel (VMT), emissions from the vehicles making those trips, and air passenger access and egress travel times, distances, and costs for use in the Target Analysis undertaken as part of the study. This requires data on the number of air passenger trips between each analysis zone and each airport or rail station. Therefore the demand allocation methodology addresses those air passenger trips that begin or end with a ground access or egress trip in the Bay Area or the larger surrounding

Northern California region. These passengers are referred to as origin and destination (O&D) passengers, as distinct from *connecting* passengers, who arrive and depart at the airport by air and only use the airport to change flights. Thus the total air passenger trips allocated to a given airport in the regional demand allocation analysis will not add up to the total passenger traffic at that airport, the difference being the connecting passengers.

Apart from the estimation of ground access and egress trips resulting from a given system development scenario, the distribution of regional air passenger demand by analysis zone is also needed to estimate the number of air passenger trips that might be attracted to air service at secondary airports within the region or improved air service at airports outside the region, since proximity to those airports is an important factor in determining how much of the regional demand might be attracted to each airport.

Although a given O&D passenger may begin the airport access trip for their departing flight at a different place from where they end the egress trip from their arriving flight (for example if a Bay Area resident begins their air trip from their workplace but on returning goes directly home), it is assumed for simplicity that in the aggregate the process is symmetrical and thus the analysis only considers ground access trips and doubles the resulting measures of ground travel.

The approach used to allocate air passenger trips to airports was based on calculating the number of forecast air passenger trips that are closest to each airport in the region. In the case of air passengers allocated to potential new secondary airports in the region, where the level of air service is likely to be quite limited, the number of forecast air passenger trips with trip ends closer to any given secondary airport was adjusted to reflect the likely potential air service at that airport.

Analysis Zones

An initial analysis was undertaken to determine the proportion of the regional air passenger demand that had (or will have) ground access trip ends closest to a given airport in 2006, 2020 and 2035. This analysis focused on domestic O&D air trips, since it is expected that the vast majority of the international O&D air trips would continue to use San Francisco International Airport.

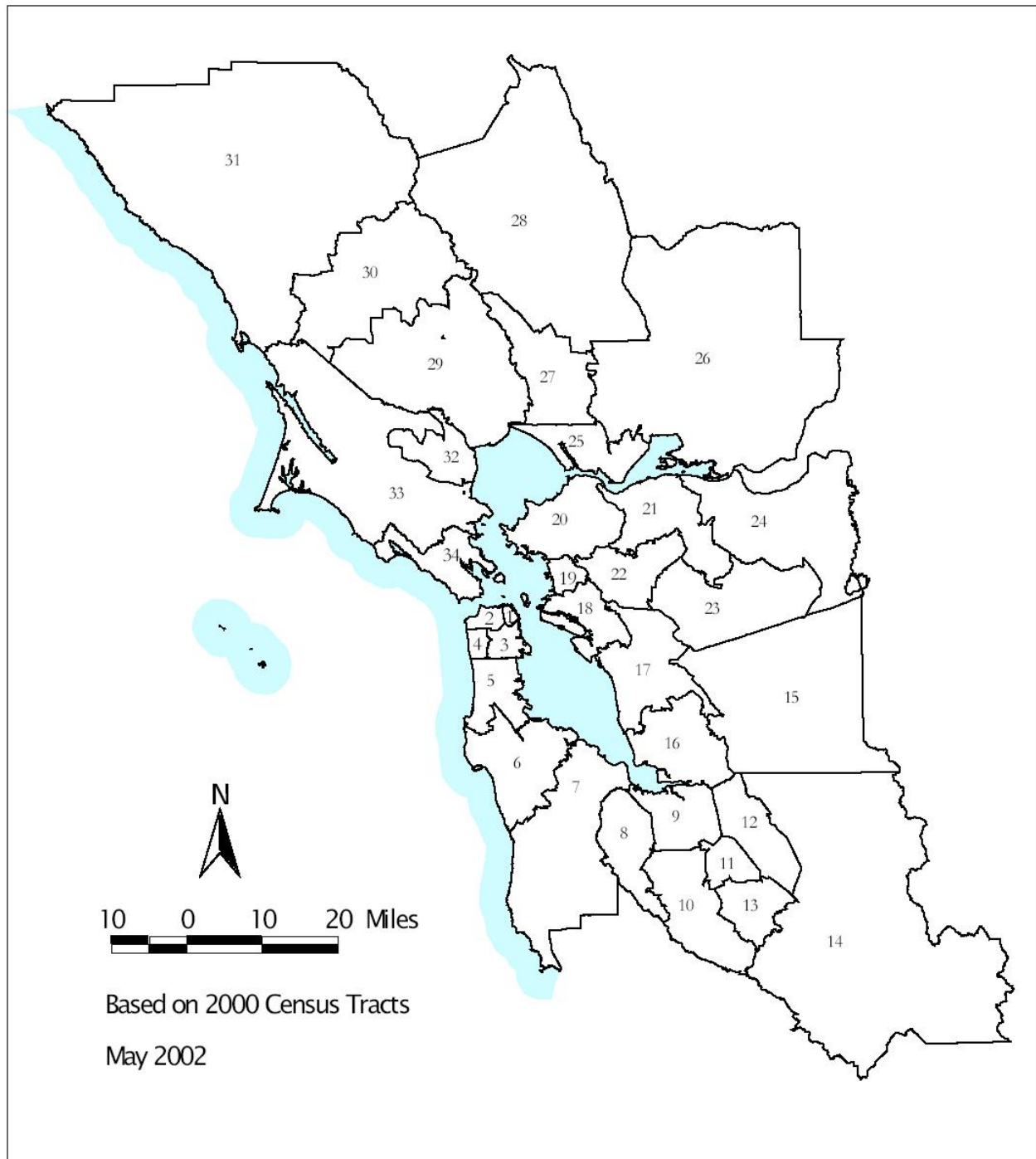
In order to determine the closest airport to each air passenger trip end, the region was divided into a system of analysis zones and the closest airport to each zone determined, as discussed below. All air passenger trips with trip ends in a given zone were assumed to have the same closest airport. For the initial demand allocation to the three primary commercial service airports, Oakland International Airport (OAK), San Francisco International Airport (SFO) and Mineta San José International Airport (SJC), the analysis zones were based on the 34 Metropolitan Transportation Commission (MTC) travel analysis superdistricts, as shown in Figure 1. The closest airport to each superdistrict was determined based on the average 2006 a.m. peak highway travel time from the zone to each airport. In most cases this can be easily determined by inspection. In a few cases where the average highway travel time from a given zone to two airports was fairly similar (less than 10 minutes), the air passenger trips with trip ends in the zone were divided equally between the two airports.

In the case of existing or potential new secondary airports within the region (termed the Internal Secondary Airports Scenario), the size of the superdistricts is too large for effective analysis, since some air passenger trips with trip ends in the superdistricts surrounding or near each secondary airport will be closer to the secondary airport, while others will be closer to one of the primary commercial service airports. Therefore service areas for the secondary airports were defined based on the 1,454 MTC travel analysis zones (TAZs) that are closer to the secondary airport than any of the primary commercial service airports.

For the purpose of this more detailed analysis, the closeness to each airport was based on the forecast TAZ to TAZ a.m. peak highway travel times for 2035 developed by the MTC regional travel demand analysis model using the *Projections 2007* regional socioeconomic forecasts prepared by the Association of Bay Area Governments (ABAG).¹

A significant number of air passenger trips using the three primary commercial service airports (about 9 percent of O&D trips) have trip ends outside the nine-county Bay Area. In order to account for these external trips, a set of external zones were defined, based on the counties surrounding the Bay Area and groups of counties further away, as shown in Table 1.

¹ Metropolitan Transportation Commission, *Superdistrict and County Summaries of ABAG's Projections 2007: 2000-2035 – Data Summary*, Oakland, California, August 2007.



Source: Metropolitan Transportation Commission

Figure 1. Bay Area Travel Analysis Superdistricts

Table 1. External Travel Analysis Zones

Zone	Name	Counties
111	Lake County	
112	Mendocino County	
113	Merced County	
114	Monterey County	
115	Sacramento County	
116	San Benito County	
117	San Joaquin County	
118	Santa Cruz County	
119	Stanislaus County	
120	Yolo County	
131	Northern California	Butte, Colusa, Del Norte, Glenn, Humboldt, Lassen, Modoc, Plumas, Shasta, Sutter, Tehama, Trinity, Yuba
132	Sierra	Alpine, Amador, Calaveras, El Dorado, Inyo, Mariposa, Mono, Nevada, Placer, Sierra, Tuolumne
133	Central Valley	Fresno, Kern, Kings, Madera, Tulare
134	Central Coast	San Luis Obispo, Santa Barbara
135	Southern California	Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura

A number of TAZs and external zones in the north and east of the region are closer to Sacramento International Airport (SMF) than to the various potential secondary airports. Since it is unlikely that the future air service at any of the secondary airports in the markets likely to be served from those airports would be better than the air service available at SMF in those markets, the service area for the secondary airports in the initial analysis excluded those zones (TAZs or external zones) that are closer to SMF. These service areas were subsequently reduced further, as discussed below.

Since the external zones are not part of the nine-county Bay Area, their highway network is not included in the MTC highway network data used to determine travel times and distances in the analysis. Therefore travel times and distances from each zone to the three primary Bay Area airports, and other Bay Area airports or planned high-speed rail stations where needed, were obtained from the online trip-planning tool Mapquest by selecting a representative city or town within each of the external zones as the trip origin.

Assignment of Regional Air Passenger Trips to Zones

It was assumed that the future distribution of regional air travel demand for each forecast year would vary from the 2007 baseline based on changes in the forecast regional distribution of population, households and income. In order to calculate the proportion of the forecast regional air travel demand in a given future year that have trip ends within a given analysis zone, trip generation models were developed that could forecast the number of air passenger trips from each analysis zone as a function of the zone socioeconomic characteristics.

Separate trip generation models were developed for O&D air trips in domestic and international markets. For the purpose of allocating forecast demand to internal secondary airports, an assignment of air trips to TAZs was only required for domestic air trips, since it was assumed that air service at the internal secondary airports would only be provided in a limited number of domestic markets. However, an assignment of forecast international air trips to TAZs was required to analyze the number of ground access trips to each airport under the various scenarios, since this analysis was performed at the TAZ level and the ground access trips to the three primary airports include international air trips. Although the majority of international air trips will continue to use SFO, there is already a small amount of international air service at OAK and SJC, and this is forecast to increase in the future (about a five-fold increase at each airport from 2007 to 2035, although both airports together will only account for about 7 percent of the total regional international passengers in 2035). Therefore an assignment of both domestic and international trips was performed at the TAZ level.

The trip generation model considered the following four market segments:

- Resident trips from home origins
- Resident trips from non-home origins
- Visitor trips from home origins
- Visitor trips from non-home origins

The first step in developing the trip generation procedure was to identify the distribution of domestic and international O&D air passenger trips by analysis zone in 2006. In the case of air passenger trips using OAK and SFO, this was obtained directly from the results of the MTC 2006 Airline Passenger Survey. However, SJC was not included in the 2006 survey and the most recent air passenger survey for SJC was performed for MTC in 2001/2002. It was assumed that the geographic distribution of trip ends of air passenger trips using SJC did not change

significantly from 2001/2002 to 2006, although of course the total number of such trips changed. The results of the air passenger surveys at each airport were factored up to the total number of domestic O&D passengers at each airport in 2006 in each of the four market segments and summed to give the regional total of air passenger trip ends in 2006 by market segment in each analysis zone.

A trip generation model for domestic home-origin resident trips was then estimated from the observed 2006 superdistrict trip ends and the 2006 superdistrict socioeconomic characteristics obtained from the MTC summary of *ABAG Projections 2007* by superdistrict cited above, giving the following relationship:

$$\text{Pax/Pop} = 5.651 - 156.1 / (\text{AHHI} - 10)$$

where Pax = Air passenger trips from zone

Pop = Zone population

AHHI = Average household income in zone (in thousand 1989 dollars²)

While the estimated model coefficients were statistically significant, the data showed a wide degree of scatter about the estimated relationship. Some of this scatter is due to limitations of the survey sample size as well as the procedure for combining the results from the three surveys, while the remainder of the scatter may be due to factors not included in the model. Further investigation of these possible factors was beyond the scope of the study. In order to reduce the effect of the scatter, an adjustment factor was computed for each superdistrict that corrected the model results to the observed (i.e. the survey) distribution of trip ends.

The trip generation model was then applied using the projected socioeconomic data for each superdistrict to calculate the number of resident home-origin trips in 2035 (or other future year) in each superdistrict. The total number of regional home-origin trips in 2035 was calculated from the forecast number of domestic resident O&D passengers, assuming that the percentage of resident trips with home origins remained unchanged from 2006. It was further assumed that the proportion of resident trips from external zones also remained unchanged from 2006. The resident home-origin trips from each of the 34 superdistricts projected by the trip generation model were then scaled to agree with the total number of resident home-origin trips forecast for the region.

² Note that ABAG reports household income in constant 2005 dollars in its reports on *Projections 2007*, but MTC converts these values to constant 1989 dollars for consistency with its travel demand models.

It was assumed that the geographic distribution of resident trips from non-home origins remained unchanged from 2006, since these trips are largely those originating from businesses, colleges, and similar locations and there is no basis for projecting how the distribution of such trip ends might change in the future.

The geographic distribution of home-origin visitor trips (i.e. visitors staying at the homes of residents of the region) was projected by applying the ratio of visitor home-origin trips to resident home-origin trips observed in 2006 for each superdistrict to the forecast number of resident home-origin trips by superdistrict in 2035. The resulting number of projected visitor home-origin trips was then scaled to agree with the regional total of such trips in the same way as for resident home-origin trips.

Finally, the number of visitor trips from non-home origins in each superdistrict was projected by assuming that the geographical distribution of such trips remained unchanged from 2006. These trips largely originate from hotels, with a smaller number from businesses and other types of locations, and as with resident non-home origin trips, there is no basis for projecting how the distribution of such trip ends might change in the future.

A similar process was followed to develop projections of air passenger trips by TAZ. The number of resident home-based trips in each TAZ was projected using the trip generation model with the projected population and average household income for the TAZ³ and the relevant superdistrict adjustment factor. An additional adjustment factor was calculated to ensure that the total projected trips for the TAZs in each superdistrict summed to the superdistrict total. The TAZ share of the superdistrict resident trips from non-home origins and visitor home-origin and non-home-origin trips was calculated for each TAZ from the 2006 and 2001/2002 survey data, and then used to distribute the forecast superdistrict trips to TAZs.

When the resident home-origin trip generation model was applied at the TAZ level, the average household income in some TAZs was low enough to give a negative value of trips per person for the zone. Therefore a minimum value of 0.2 air passenger trips per person was used for these zones. The adjustment factor for total superdistrict trips ensured that the effect of this was only to change the distribution of trips between TAZs within the superdistrict.

³ Obtained from an unpublished MTC data file allocating the ABAG *Projections 2007* socio-economic data to TAZs.

Since no socioeconomic projections were available for the external zones, the forecast trips from each external zone in 2035 were calculated assuming that each zone generated the same proportion of total regional resident and visitor trips as in 2006.

A similar process was followed for international trips. The corresponding trip generation model for international home-origin resident trips was estimated from the observed 2006 superdistrict trip ends and the 2006 superdistrict socioeconomic characteristics, giving the following relationship:

$$\text{Pax/Pop} = 0.96 - 35.1 / \text{AHHI}$$

where the variables were defined as in the model for domestic trips. Superdistrict adjustment factors were calculated as for domestic trips, and the allocation of the four market segments followed the same procedure as for domestic trips.

Forecast Demand by Analysis Zone

The results of the foregoing process for the Baseline Scenario Base Case Forecast are shown in the attachments for the MTC superdistricts and external zones. Attachment A presents the demand assignment for 2007, Attachment B presents the demand assignment for 2020, while Attachment C presents the demand assignment for 2035.

(Note: The corresponding demand assignment tables by TAZ each comprises 1,454 rows and are too lengthy to include.)

It should be noted that the apparent precision of the values for a given zone is a consequence of the allocation and expansion process, and should be interpreted with caution. The accuracy of the estimated assignment of annual air passenger trips to zones is constrained by the sample size of the air passenger survey data upon which the assignment procedure is based. The fact that some zones have no trips assigned to them in a particular sub-category does not mean that in reality there would be no such trips from that zone, only that there were none reported in the air passenger survey. Similarly, some zones may have more trips assigned to them than others only because there happened to be more survey responses from those zones, or the air parties from those zones in the survey happened to have more passengers in them, not because in reality those zones generate more air passenger trips.

The expansion factor from survey responses to annual air passenger trips varies somewhat by category of trip from about 3,200 for visitor domestic trips to about 5,400 for

resident international trips, with an overall expansion factor across all trip types of about 3,800. Thus the estimated number of annual trips from a given zone could easily vary from the actual number by over 11,000 trips (equivalent to three survey responses with an average air party size).

Demand Allocation to Airports and Rail Stations under Each Analysis Scenario

Once the actual or forecast regional demand in a given year was assigned to each of the analysis zones, it was then necessary to allocate the passenger demand from each zone to the regional airports considered in each Target Analysis scenario, and in the case of the High-Speed Rail Scenario to allocate the air passenger demand diverted to high-speed rail to the relevant high-speed rail stations.

Baseline Scenario

The allocation of the demand from a given zone to each airport in the Baseline Scenario was performed as follows:

1. The number of passenger trips from each superdistrict and external zone using a given airport was initially calculated from the observed share of passenger trips using that airport in the most recent air passenger surveys. Since the surveys at each airport used different sampling rates and were performed in different years, the survey results from each airport were factored up to the total O&D traffic at that airport in 2006 before calculating the airport shares. Separate airport shares were calculated for the following four trip types:
 - Resident domestic trips
 - Visitor domestic trips
 - Resident international trips
 - Visitor international trips

The same airport shares for a given trip type were used for trips from home origins and other origins since the survey sample size was not large enough to support separate airport shares for the different origin types and

it seems reasonable to assume that the airport choice of a passenger of a given trip type from a given zone would not be greatly influenced by the type of the trip origin.

2. The resulting number of passenger trips from each zone to each airport by trip type and trip origin type (home origins and other origins) was then factored to give the correct total number of O&D passengers forecast for that airport, with separate adjustment factors calculated for domestic and international trips (the demand forecasts did not distinguish between residents trips and visitor trips).
3. The passenger trips from each TAZ to each airport for a given trip type and trip origin type were then calculated by assuming that the TAZ share of the relevant superdistrict total number of trips to that airport remained constant.

This approach was then tailored for each of the other scenarios to reflect the factors specific to that scenario, as discussed in the following sections.

Demand Redistribution Scenario

This scenario assumes that some demand is redistributed from SFO to OAK and SJC. The forecast projections of the change in air passenger traffic at each airport for this scenario did not consider where in the region those passenger trips originated or whether the diverted trips were drawn proportionately from each type of trip or trip origin. Therefore it was assumed that the resulting passenger trips at OAK and SJC were distributed across the analysis zones in proportion to the distribution for the Baseline Scenario. This implicitly assumes that trips from analysis zones that had a higher use of OAK or SJC in the Baseline Scenario were more likely to be diverted to those airports in the Redistribution Scenario, which seems intuitively reasonable.

Internal Secondary Airports Scenario

This scenario assumes that air service would be introduced or expanded at three secondary airports in the region: Buchanan Field in Concord, Charles M. Schultz Sonoma County Airport, and a joint use airport at Travis Air Force Base (AFB) in Solano County. At present commercial air service is only available at Sonoma County Airport. As part of preparing

regional demand forecasts for each of the Target Analysis scenarios, projections were made of the number of air passenger trips attracted to each of the internal secondary airports considered in this scenario from each of the three primary Bay Area airports, as well as trips that would use SMF in the Baseline Scenario that would be attracted to air service at Travis AFB (termed *recaptured trips*).

Passenger diversion for the internal secondary airports was based on an analysis of potential high-density short-haul markets and regional airline connecting hubs that could support future service based on forecast passenger demand. Future catchment area demand for the internal secondary airports was based on the Base Case forecast of passengers in ground zones with a drive time advantage of at least 30 minutes over the closest primary Bay Area airport or SMF. The forecasts of potential air passengers at each secondary airport were then translated into passenger diversion from the primary airports based on current primary airport usage patterns.

The demand allocation for the internal secondary airports scenario involved three steps.

1. The catchment area for each secondary airport was defined in terms of the TAZs at least 30 minutes closer to the secondary airport than any of the primary airports or SMF and closer to the secondary airport in question than to any other secondary airport. In addition, the catchment area for Sonoma County Airport includes the two external zones (Lake County and Mendocino County) that are closer to that airport than any primary or other secondary airport. The travel times to an airport from a given zone were based on the forecast TAZ to TAZ a.m. peak highway travel times for 2035 developed by the MTC regional travel demand analysis model, as discussed above. The total number of domestic air passenger trips from each catchment area to each of the primary airports in the Baseline Scenario was then calculated and the diversion rate for each primary airport determined from the forecast number of domestic air passenger trips diverted from that airport to the relevant secondary airport. It was assumed in the absence of any more detailed analysis that the diversion rate for each catchment area was the same for all TAZs within the

catchment area. It was further assumed that the same diversion rate would apply to all types of domestic trips.

2. The residual trips at the three primary airports were distributed across the analysis zones by adjusting the distribution in the Baseline Scenario by the number of diverted trips from each TAZ or external zone, calculated using the appropriate diversion rate.
3. The number of trips from each analysis zone to the relevant secondary airport was then calculated by applying the appropriate diversion rate to the number of trips from the zone to each primary airport in the Baseline Scenario. The diverted trips were then summed across the three primary airports.

No demand allocation was performed for the trips from SMF recaptured by Travis AFB since these trips were not counted in the Baseline Scenario.

External Airports Scenario

This scenario assumes that air service improves at three airports outside the region, Sacramento International Airport (SMF), Stockton Metropolitan Airport (SCK), and Monterey Peninsula Airport (MRY), and reduces the number of trips from the external zones served by those airports that use the Bay Area airports. As part of preparing regional demand forecasts for each of the Target Analysis scenarios, projections were made of the number of air passenger trips using each of the three primary Bay Area airports in the Baseline Scenario that would be recaptured by each of the three external airports.

The estimates of passenger recapture for the external airports were based on data and studies collected from each of the external airports. The airports provided a range of data and studies including market demand studies, passenger leakage analyses, air passenger surveys, airport forecasts, and air service development targets. These data provided the basis for forecasts of new nonstop services at the external airports and estimates of how many passengers the new services could recapture from the primary Bay Area airports.

It could be expected that the passengers recaptured by the external airports would have trip origins in the external zones served by those airports, and thus would simply reduce the

number of trips from those zones to each airport. However, the forecasts of passengers recaptured from OAK by SMF exceeded the number of trips to OAK from the external zones served by SMF, while the forecasts of passengers recaptured from OAK by MRY accounted for almost all the trips to OAK from the external zones served by MRY, which seems unlikely. Therefore it was assumed that the new services at SMF would draw some trips from the Solano County superdistrict closest to SMF (superdistrict 26) and the new services at MRY would draw some trips from the southernmost Santa Clara County superdistrict (superdistrict 14).

Using the forecast number of recaptured passengers, recapture rates were calculated from the total number of domestic passenger trips from the assumed service area for each external airport to each of the Bay Area primary airports in the Baseline Scenario. In the absence of any more detailed analysis, the same recapture rates were applied to all trip types and each analysis zone in the assumed service area. These recapture rates were then used to reduce the number of domestic passenger trips to each primary Bay Area airport from each external zone (or TAZ within the two superdistricts assumed to form part of the service areas for SMF and MRY respectively in the case of OAK).

High-Speed Rail Scenario

This scenario assumes that some of the air passenger demand in the Baseline Scenario would be diverted to the planned California High-Speed Rail (HSR) System. As part of preparing regional demand forecasts for each of the Target Analysis scenarios, projections were made of the number of air passenger trips using each of the three primary Bay Area airports in the Baseline Scenario that would be diverted to the high-speed rail service. These projections were based on the regional-level ridership forecasts prepared for the California High-Speed Rail Authority and assumed that the diversion rate of air passenger trips using OAK in the Baseline Scenario would be only 75 percent of that of air passenger trips using SFO and SJC, due to the greater accessibility of the high-speed rail stations for the majority of passengers using SFO and SJC compared to the majority of passengers using OAK.

The approach to the demand allocation for the HSR Scenario follows that for the Internal Secondary Airports Scenario. Diversion rates of domestic air passenger trips to HSR were calculated for each airport and then used to reduce the number of air passenger trips from each analysis zone to each airport from the levels in the Baseline Scenario. In the absence of more

detailed analysis, the same diversion rate was applied to all types of domestic trips and all analysis zones for each airport.

The number of passengers diverted from each analysis zone to each HSR station was then calculated by assigning each TAZ or external zone to the closest HSR station, where the distance from a given zone to each HSR station was based on the MTC highway network distance for free-flow conditions in 2000. The number of trips from each analysis zone to each airport that were projected to be diverted to HSR were then allocated to the closest HSR station and the total number of trips from each zone to each station summed across the three airports.

It should be noted that this allocation process results in a varying overall diversion rate for each zone since the diversion rates for trips from the same zone to each airport are different, as are the proportions of trips from each zone using each airport. This is not unreasonable, given the assumptions of the analysis, since the relative accessibilities of the three airports and the high-speed rail stations vary for each zone, as do the proportions of the trips from a given zone to each airport that are in markets that would be served by the HSR system (since the share of total domestic O&D trips at each airport that are in markets served by the HSR system are different). A more detailed analysis would need to be based on a zone-by-zone analysis of expected diversion rates, which was considered to be beyond the scope of the study.

New Air Traffic Control Technologies and Demand Management Scenarios

Neither of these two scenarios involves any redistribution of demand between the three primary airports, and so the demand allocation is the same as for the Baseline Scenario.

Summary and Conclusions

The forecast demand allocation methodology adopted for the Regional Airport System Plan Analysis update is based on the use of a trip generation model for resident home-origin trips that expresses the number of annual air passenger trips from a given zone as a function of the zonal population and average household income in the zone. Visitor home-origin trips are then projected based on the observed ratio of visitor home-origin trips to resident home-origin trips in the most recent air passenger surveys. Resident and visitor air passenger trips from non-home origins were assumed to account for the same proportion of total regional resident to visitor trips,

with the same geographical distribution in the region, as observed in the most recent air passengers surveys.

Once the forecast regional air passenger demand has been distributed to analysis zones, the demand from each zone was then allocated to each of the regional airports on the basis of the current (2006) pattern of airport use and the proximity of the zone to each of the airports based on average highway travel times, with appropriate adjustments for differences in air service in the case of the internal secondary airports.

Although the forecast demand allocation methodology can account for future changes in the regional distribution of population and household incomes on air passenger trips from home origins, it assumes that the regional geographical distribution of trips from non-home origins remains unchanged over time. This assumption should be examined and refined if necessary as part of future work.

The proposed approach to calculating the future traffic at each airport for each of the airport system development scenarios, particularly the Internal Secondary Airports Scenario, (and the air trips diverted to high-speed rail at each rail station for the High-Speed Rail Scenario) also assumes that the regional geographical distribution of air passenger trips is the same for all air markets. This assumption should also be examined and refined if necessary as part of future work.

Attachment A

Forecast Demand Assignment to Superdistricts and External Zones

Baseline Scenario Base Case Forecast – 2007

Superdistrict	Domestic Trips		International Trips		Total
	Resident	Visitor	Resident	Visitor	
1	1,072,549	5,998,173	118,630	1,319,707	8,509,058
2	1,042,961	963,900	194,630	107,811	2,309,302
3	1,122,638	419,855	123,494	62,853	1,728,839
4	487,578	147,248	91,000	13,426	739,253
5	803,441	777,555	116,727	257,855	1,955,578
6	844,752	727,471	162,739	86,241	1,821,203
7	644,497	455,542	112,242	43,358	1,255,640
8	951,567	707,259	190,158	71,698	1,920,681
9	1,078,188	937,478	248,889	95,767	2,360,322
10	617,310	372,182	158,930	51,485	1,199,908
11	885,145	1,041,910	94,493	58,289	2,079,836
12	382,350	185,474	144,373	24,939	737,135
13	700,355	227,243	92,069	27,916	1,047,583
14	279,661	257,730	34,006	13,917	585,315
15	766,750	526,158	68,551	14,806	1,376,265
16	621,671	425,858	178,504	46,061	1,272,095
17	588,935	315,906	157,028	29,649	1,091,517
18	1,497,138	1,249,305	169,588	40,704	2,956,735
19	966,677	576,790	111,915	89,528	1,744,910
20	422,953	187,672	65,654	7,145	683,424
21	508,103	311,312	71,583	23,100	914,097
22	613,603	324,102	125,559	44,115	1,107,379
23	459,643	212,312	32,705	17,649	722,309
24	359,698	117,642	82,413	1,056	560,809
25	263,206	98,509	39,923	59,050	460,689
26	156,097	74,013	41,295	6,936	278,341
27	146,607	247,123	27,095	32,096	452,921
28	66,501	200,040	53,720	24,287	344,548
29	394,382	286,014	59,451	17,591	757,438
30	489,016	307,462	70,427	10,624	877,530
31	133,585	124,941	21,771	0	280,296
32	180,152	63,848	21,565	3,381	268,945
33	366,135	266,510	37,583	20,438	690,666
34	354,882	256,524	53,244	3,339	667,989
Total Bay Area	20,268,725	19,391,063	3,371,952	2,726,815	45,758,555
External Zones	1,879,911	1,555,985	847,348	159,962	4,443,205
Total	22,148,636	20,947,048	4,219,299	2,886,777	50,201,760

Forecast Demand Assignment to Superdistricts and External Zones (cont.)

Baseline Scenario Base Case Forecast – 2007

External Zone		Domestic Trips		International Trips		Total
		Resident	Visitor	Resident	Visitor	
111	Lake County	21,308	15,732	27,114	7,209	71,363
112	Mendocino County	107,918	51,908	8,061	0	167,886
113	Merced County	42,596	20,047	0	527	63,170
114	Monterey County	252,024	509,917	43,797	62,382	868,120
115	Sacramento County	205,199	104,408	302,475	39,775	651,858
116	San Benito County	51,465	24,646	12,100	1,866	90,077
117	San Joaquin County	199,700	79,218	118,538	17,516	414,972
118	Santa Cruz County	514,916	353,276	65,907	18,718	952,817
119	Stanislaus County	171,718	91,854	90,155	2,392	356,120
120	Yolo County	0	5,514	554	0	6,068
131	Northern California	65,751	25,787	43,969	0	135,508
132	Sierra	154,804	87,941	104,427	3,973	351,145
133	Central Valley	55,582	70,237	27,481	0	153,300
134	Central Coast	25,285	25,283	1,108	0	51,676
135	Southern California	11,643	90,218	1,662	5,603	109,126
Total		1,879,911	1,555,985	847,348	159,962	4,443,205

Domestic Trips

Baseline Scenario Base Case Forecast – 2007

Superdistrict	Resident Trips		Visitor Trips		Total
	Home Origins	Other Origins	Home Origins	Other Origins	
1	472,459	600,089	295,734	5,702,439	7,070,722
2	963,646	79,314	418,718	545,182	2,006,861
3	979,011	143,627	322,554	97,301	1,542,493
4	414,128	73,450	119,853	27,395	634,826
5	671,854	131,586	172,060	605,495	1,580,996
6	760,958	83,794	267,521	459,951	1,572,223
7	577,770	66,727	213,009	242,533	1,100,040
8	833,352	118,216	291,324	415,935	1,658,826
9	725,739	352,450	261,545	675,933	2,015,666
10	559,040	58,270	230,872	141,310	989,493
11	642,535	242,609	345,163	696,747	1,927,054
12	300,152	82,198	117,015	68,459	567,824
13	631,253	69,102	172,313	54,930	927,598
14	218,049	61,612	129,470	128,261	537,391
15	682,692	84,058	216,314	309,844	1,292,907
16	553,005	68,666	245,617	180,241	1,047,529
17	528,090	60,845	168,304	147,602	904,840
18	1,151,823	345,315	438,729	810,577	2,746,443
19	831,661	135,016	257,651	319,139	1,543,467
20	390,495	32,458	82,467	105,204	610,625
21	467,948	40,154	126,820	184,492	819,415
22	525,599	88,004	183,540	140,562	937,705
23	434,267	25,376	95,827	116,486	671,955
24	341,794	17,905	95,540	22,102	477,340
25	236,154	27,052	57,410	41,099	361,716
26	136,857	19,239	30,458	43,555	230,110
27	137,236	9,371	48,712	198,411	393,731
28	62,653	3,848	28,034	172,006	266,541
29	347,867	46,515	117,621	168,393	680,396
30	419,414	69,602	95,775	211,687	796,479
31	118,193	15,391	62,689	62,252	258,525
32	151,541	28,611	37,182	26,666	244,000
33	310,249	55,886	127,848	138,662	632,646
34	330,120	24,763	121,040	135,484	611,406
Total Bay Area	16,907,603	3,361,122	5,994,727	13,396,336	39,659,788
External Zones	1,479,028	400,883	716,327	839,658	3,435,896
Total	18,386,631	3,762,005	6,711,054	14,235,994	43,095,684

Domestic Trips (cont.)

Baseline Scenario Base Case Forecast – 2007

External Zones		Resident Trips		Visitor Trips		Total
		Home Origins	Other Origins	Home Origins	Other Origins	
111	Lake County	17,460	3,848	2,522	13,209	37,040
112	Mendocino County	89,175	18,742	36,270	15,638	159,826
113	Merced County	33,225	9,371	15,684	4,363	62,643
114	Monterey County	211,744	40,280	165,153	344,764	761,941
115	Sacramento County	135,256	69,943	38,717	65,691	309,607
116	San Benito County	49,067	2,398	24,646	0	76,111
117	San Joaquin County	186,481	13,219	45,459	33,759	278,918
118	Santa Cruz County	470,994	43,922	196,210	157,065	868,192
119	Stanislaus County	133,737	37,982	55,064	36,790	263,572
120	Yolo County	0	0	0	5,514	5,514
131	Northern California	16,723	49,028	11,327	14,460	91,538
132	Sierra	103,603	51,201	26,647	61,294	242,744
133	Central Valley	18,097	37,485	11,485	58,752	125,819
134	Central Coast	4,684	20,602	16,557	8,726	50,568
135	Southern California	8,782	2,861	70,586	19,632	101,861
Total		1,479,028	400,883	716,327	839,658	3,435,896

International Trips

Baseline Scenario Base Case Forecast – 2007

Superdistrict	Resident Trips		Visitor Trips		Total
	Home Origins	Other Origins	Home Origins	Other Origins	
1	107,083	11,546	65,869	1,253,838	1,438,336
2	183,638	10,992	49,841	57,970	302,441
3	123,494	0	37,346	25,507	186,347
4	91,000	0	13,426	0	104,427
5	100,239	16,488	27,167	230,688	374,582
6	162,739	0	31,898	54,343	248,979
7	111,688	554	17,575	25,783	155,600
8	188,496	1,662	13,199	58,499	261,855
9	220,300	28,589	45,877	49,890	344,655
10	147,384	11,546	25,427	26,058	210,415
11	87,290	7,203	29,050	29,239	152,782
12	131,718	12,654	16,903	8,036	169,311
13	92,069	0	9,618	18,298	119,985
14	33,452	554	5,882	8,036	47,923
15	68,551	0	7,046	7,760	83,357
16	178,504	0	31,368	14,694	224,566
17	157,028	0	18,836	10,814	186,677
18	164,091	5,496	24,037	16,667	210,292
19	111,915	0	57,088	32,441	201,443
20	65,654	0	7,145	0	72,799
21	60,590	10,992	22,824	276	94,682
22	120,063	5,496	36,906	7,209	169,674
23	32,705	0	6,836	10,814	50,354
24	82,413	0	1,056	0	83,469
25	28,931	10,992	59,050	0	98,974
26	41,295	0	6,936	0	48,231
27	27,095	0	13,776	18,320	59,190
28	31,735	21,985	13,474	10,814	78,007
29	59,451	0	6,778	10,814	77,042
30	64,931	5,496	3,415	7,209	81,051
31	10,779	10,992	0	0	21,771
32	16,069	5,496	3,381	0	24,945
33	37,583	0	16,833	3,605	58,021
34	53,244	0	3,339	0	56,583
Total Bay Area	3,193,216	178,736	729,197	1,997,618	6,098,767
External Zones	637,940	209,408	90,396	69,566	1,007,309
Total	3,831,156	388,143	819,593	2,067,184	7,106,076

International Trips (cont.)

Baseline Scenario Base Case Forecast – 2007

External Zone		Resident Trips		Visitor Trips		Total
		Home Origins	Other Origins	Home Origins	Other Origins	
111	Lake County	27,114	0	0	7,209	34,323
112	Mendocino County	8,061	0	0	0	8,061
113	Merced County	0	0	527	0	527
114	Monterey County	43,797	0	17,474	44,907	106,179
115	Sacramento County	198,048	104,427	39,775	0	342,251
116	San Benito County	12,100	0	1,866	0	13,966
117	San Joaquin County	107,545	10,992	17,516	0	136,054
118	Santa Cruz County	54,915	10,992	2,371	16,347	84,625
119	Stanislaus County	84,104	6,050	2,392	0	92,547
120	Yolo County	554	0	0	0	554
131	Northern California	32,977	10,992	0	0	43,969
132	Sierra	65,954	38,473	3,973	0	108,400
133	Central Valley	0	27,481	0	0	27,481
134	Central Coast	1,108	0	0	0	1,108
135	Southern California	1,662	0	4,500	1,102	7,265
Total		637,940	209,408	90,396	69,566	1,007,309

Attachment B

Forecast Demand Assignment to Superdistricts and External Zones

Baseline Scenario Base Case Forecast – 2020

Superdistrict	Domestic Trips		International Trips		Total
	Resident	Visitor	Resident	Visitor	
1	1,366,766	7,201,519	209,833	1,973,662	10,751,780
2	1,053,238	1,069,753	248,485	147,728	2,519,204
3	1,257,983	478,354	176,010	89,464	2,001,811
4	520,002	159,443	122,283	17,494	819,221
5	922,437	918,794	171,055	380,942	2,393,228
6	896,763	830,529	218,972	122,262	2,068,526
7	669,872	508,749	146,930	60,570	1,386,121
8	1,017,864	805,131	257,282	104,128	2,184,405
9	1,312,505	1,131,443	393,818	144,424	2,982,190
10	660,208	414,949	216,002	72,179	1,363,338
11	1,311,764	1,386,216	187,230	99,204	2,984,413
12	456,357	223,221	221,674	37,091	938,343
13	770,809	255,516	129,000	40,221	1,195,545
14	366,939	329,332	58,780	21,783	776,834
15	895,903	623,659	102,396	21,721	1,643,679
16	669,907	478,777	243,342	63,269	1,455,295
17	700,509	378,068	237,139	43,629	1,359,345
18	1,907,728	1,542,362	277,898	62,927	3,790,915
19	1,125,339	682,166	165,645	130,072	2,103,222
20	568,116	238,166	112,234	11,843	930,360
21	595,554	369,528	107,515	33,649	1,106,245
22	638,882	356,146	164,262	57,515	1,216,805
23	492,820	241,723	44,587	25,084	804,214
24	464,309	151,431	136,089	1,691	753,520
25	400,964	139,540	79,963	114,683	735,150
26	247,284	102,312	85,917	13,993	449,505
27	181,809	297,184	42,950	48,361	570,305
28	68,779	233,590	70,782	33,262	406,412
29	446,316	334,064	85,590	25,509	891,478
30	590,850	369,209	108,644	15,806	1,084,509
31	158,307	149,176	32,935	0	340,418
32	203,389	73,813	30,986	4,710	312,898
33	396,320	302,614	51,522	27,725	778,181
34	350,992	280,347	66,498	4,043	701,881
Total Bay Area	23,687,581	23,056,824	5,004,248	4,050,643	55,799,296
External Zones	2,215,935	1,852,957	1,257,532	233,318	5,559,743
Total	25,903,517	24,909,781	6,261,780	4,283,961	61,359,039

Forecast Demand Assignment to Superdistricts and External Zones (cont.)

Baseline Scenario Base Case Forecast – 2020

External Zone		Domestic Trips		International Trips		Total
		Resident	Visitor	Resident	Visitor	
111	Lake County	25,125	18,717	40,239	10,698	94,779
112	Mendocino County	127,257	61,860	11,963	0	201,080
113	Merced County	50,207	23,897	0	758	74,862
114	Monterey County	297,230	606,985	64,998	91,788	1,061,001
115	Sacramento County	241,571	124,301	448,898	57,238	872,008
116	San Benito County	60,764	29,399	17,958	2,685	110,806
117	San Joaquin County	235,740	94,370	175,920	25,207	531,236
118	Santa Cruz County	607,726	420,824	97,811	27,671	1,154,033
119	Stanislaus County	202,396	109,432	133,797	3,443	449,068
120	Yolo County	0	6,557	822	0	7,379
131	Northern California	77,094	30,707	65,254	0	173,055
132	Sierra	182,261	104,674	154,978	5,718	447,631
133	Central Valley	65,217	83,566	40,784	0	189,567
134	Central Coast	29,627	30,126	1,645	0	61,397
135	Southern California	13,720	107,543	2,467	8,112	131,842
Total		2,215,935	1,852,957	1,257,532	233,318	5,559,743

Domestic Trips

Baseline Scenario Base Case Forecast – 2020

Superdistrict	Resident Trips		Visitor Trips		Total
	Home Origins	Other Origins	Home Origins	Other Origins	
1	664,943	701,823	420,300	6,781,219	8,568,285
2	960,477	92,761	421,434	648,319	2,122,991
3	1,090,007	167,976	362,645	115,708	1,736,337
4	434,100	85,902	126,865	32,578	679,445
5	768,543	153,894	198,752	720,042	1,841,231
6	798,763	98,000	283,566	546,963	1,727,292
7	591,832	78,040	220,333	288,415	1,178,621
8	879,607	138,257	310,509	494,621	1,822,995
9	900,304	412,201	327,637	803,806	2,443,948
10	592,059	68,149	246,906	168,043	1,075,157
11	1,028,024	283,739	557,659	828,556	2,697,979
12	360,224	96,133	141,811	81,410	679,578
13	689,992	80,817	190,194	65,321	1,026,325
14	294,882	72,057	176,808	152,525	696,272
15	797,594	98,308	255,200	368,460	1,519,562
16	589,600	80,308	264,439	214,339	1,148,684
17	629,349	71,160	202,543	175,525	1,078,577
18	1,503,872	403,856	578,442	963,920	3,450,090
19	967,433	157,906	302,653	379,513	1,807,505
20	530,155	37,961	113,060	125,107	806,283
21	548,592	46,962	150,134	219,394	965,081
22	535,958	102,924	188,993	167,153	995,028
23	463,141	29,678	103,201	138,522	734,543
24	443,369	20,940	125,148	26,283	615,740
25	369,326	31,638	90,665	48,875	540,504
26	224,783	22,501	50,517	51,795	349,596
27	170,849	10,960	61,237	235,947	478,993
28	64,279	4,500	29,044	204,546	302,369
29	391,915	54,401	133,814	200,250	780,379
30	509,447	81,402	117,476	251,733	960,059
31	140,306	18,001	75,148	74,028	307,483
32	169,928	33,461	42,102	31,711	277,202
33	330,959	65,361	137,720	164,894	698,934
34	322,032	28,961	119,232	161,115	631,339
Total Bay Area	19,756,645	3,930,936	7,126,187	15,930,636	46,744,405
External Zones	1,747,091	468,845	854,454	998,503	4,068,893
Total	21,503,736	4,399,781	7,980,642	16,929,139	50,813,298

Domestic Trips (cont.)

Baseline Scenario Base Case Forecast – 2020

External Zones		Resident Trips		Visitor Trips		Total
		Home Origins	Other Origins	Home Origins	Other Origins	
111	Lake County	20,625	4,500	3,009	15,708	43,842
112	Mendocino County	105,338	21,920	43,263	18,597	189,118
113	Merced County	39,247	10,960	18,708	5,188	74,104
114	Monterey County	250,121	47,109	196,998	409,986	904,215
115	Sacramento County	159,770	81,801	46,182	78,118	365,872
116	San Benito County	57,960	2,805	29,399	0	90,163
117	San Joaquin County	220,280	15,460	54,225	40,145	330,110
118	Santa Cruz County	556,358	51,368	234,045	186,779	1,028,550
119	Stanislaus County	157,975	44,421	65,682	43,750	311,828
120	Yolo County	0	0	0	6,557	6,557
131	Northern California	19,753	57,340	13,511	17,196	107,801
132	Sierra	122,380	59,881	31,785	72,889	286,935
133	Central Valley	21,377	43,840	13,699	69,867	148,784
134	Central Coast	5,533	24,094	19,750	10,376	59,753
135	Southern California	10,373	3,346	84,197	23,346	121,263
Total		1,747,091	468,845	854,454	998,503	4,068,893

International Trips

Baseline Scenario Base Case Forecast – 2020

Superdistrict	Resident Trips		Visitor Trips		Total
	Home Origins	Other Origins	Home Origins	Other Origins	
1	192,697	17,136	112,973	1,860,688	2,183,494
2	232,171	16,313	61,701	86,027	396,213
3	176,010	0	51,611	37,852	265,474
4	122,283	0	17,494	0	139,777
5	146,585	24,470	38,603	342,340	551,997
6	218,972	0	41,617	80,645	341,235
7	146,108	822	22,308	38,261	207,500
8	254,816	2,467	17,316	86,812	361,410
9	351,390	42,428	70,388	74,036	538,242
10	198,867	17,136	33,508	38,670	288,181
11	176,540	10,689	55,813	43,391	286,434
12	202,894	18,780	25,166	11,925	258,765
13	129,000	0	13,067	27,154	169,221
14	57,958	822	9,858	11,925	80,563
15	102,396	0	10,205	11,516	124,117
16	243,342	0	41,464	21,805	306,611
17	237,139	0	27,582	16,047	280,768
18	269,741	8,157	38,194	24,734	340,825
19	165,645	0	81,931	48,142	295,717
20	112,234	0	11,843	0	124,077
21	91,201	16,313	33,240	409	141,164
22	156,106	8,157	46,817	10,698	221,777
23	44,587	0	9,037	16,047	69,671
24	136,089	0	1,691	0	137,780
25	63,650	16,313	114,683	0	194,647
26	85,917	0	13,993	0	99,910
27	42,950	0	21,174	27,187	91,312
28	38,155	32,627	17,215	16,047	104,043
29	85,590	0	9,462	16,047	111,099
30	100,487	8,157	5,108	10,698	124,450
31	16,621	16,313	0	0	32,935
32	22,829	8,157	4,710	0	35,696
33	51,522	0	22,376	5,349	79,247
34	66,498	0	4,043	0	70,541
Total Bay Area	4,738,989	265,258	1,086,189	2,964,454	9,054,890
External Zones	946,754	310,778	130,083	103,235	1,490,851
Total	5,685,743	576,036	1,216,272	3,067,689	10,545,741

International Trips (cont.)

Baseline Scenario Base Case Forecast – 2020

External Zone		Resident Trips		Visitor Trips		Total
		Home Origins	Other Origins	Home Origins	Other Origins	
111	Lake County	40,239	0	0	10,698	50,937
112	Mendocino County	11,963	0	0	0	11,963
113	Merced County	0	0	758	0	758
114	Monterey County	64,998	0	25,146	66,642	156,787
115	Sacramento County	293,920	154,978	57,238	0	506,136
116	San Benito County	17,958	0	2,685	0	20,643
117	San Joaquin County	159,606	16,313	25,207	0	201,126
118	Santa Cruz County	81,498	16,313	3,413	24,259	125,483
119	Stanislaus County	124,818	8,979	3,443	0	137,240
120	Yolo County	822	0	0	0	822
131	Northern California	48,940	16,313	0	0	65,254
132	Sierra	97,881	57,097	5,718	0	160,696
133	Central Valley	0	40,784	0	0	40,784
134	Central Coast	1,645	0	0	0	1,645
135	Southern California	2,467	0	6,476	1,636	10,579
Total		946,754	310,778	130,083	103,235	1,490,851

Attachment C

Forecast Demand Assignment to Superdistricts and External Zones

Baseline Scenario Base Case Forecast – 2035

Superdistrict	Domestic Trips		International Trips		Total
	Resident	Visitor	Resident	Visitor	
1	1,829,687	9,069,176	405,003	3,337,614	14,641,478
2	1,178,815	1,272,255	371,544	235,515	3,058,130
3	1,560,421	589,927	294,553	148,864	2,593,765
4	609,395	186,137	191,223	27,033	1,013,788
5	1,101,435	1,132,638	273,821	635,492	3,143,386
6	979,616	984,974	317,374	194,924	2,476,888
7	747,637	600,239	217,220	96,791	1,661,887
8	1,147,501	959,027	384,756	171,255	2,662,540
9	1,724,422	1,440,496	713,384	250,226	4,128,528
10	747,925	483,908	327,224	115,049	1,674,105
11	1,975,495	1,906,732	393,523	188,729	4,464,479
12	584,615	282,963	386,968	63,420	1,317,966
13	923,516	306,342	208,408	66,424	1,504,689
14	462,872	412,140	100,651	36,690	1,012,352
15	1,125,322	778,270	173,698	36,429	2,113,719
16	796,350	577,199	387,508	101,835	1,862,893
17	903,240	479,058	413,256	74,424	1,869,978
18	2,685,003	2,035,559	540,078	114,851	5,375,491
19	1,423,852	854,486	283,550	219,369	2,781,257
20	752,088	305,252	200,869	20,945	1,279,154
21	735,509	457,699	179,153	55,420	1,427,781
22	717,689	414,734	243,818	86,620	1,462,861
23	553,453	287,112	66,846	40,314	947,725
24	632,862	202,577	251,859	3,092	1,090,389
25	510,311	175,614	138,311	196,019	1,020,255
26	347,082	135,762	165,716	26,670	675,229
27	224,746	369,763	71,696	80,547	746,752
28	74,476	286,388	102,567	51,576	515,008
29	528,029	405,880	135,817	41,763	1,111,490
30	735,250	459,310	182,131	26,413	1,403,104
31	196,343	184,782	55,118	0	436,243
32	241,094	88,559	49,291	7,404	386,348
33	447,491	356,900	77,089	42,059	923,539
34	369,947	323,777	92,849	5,579	792,152
Total Bay Area	29,573,488	28,805,635	8,396,872	6,799,354	73,575,350
External Zones	2,789,416	2,315,731	2,110,075	388,915	7,604,136
Total	32,362,904	31,121,367	10,506,947	7,188,269	81,179,487

Forecast Demand Assignment to Superdistricts and External Zones (cont.)

Baseline Scenario Base Case Forecast – 2035

External Zone		Domestic Trips		International Trips		Total
		Resident	Visitor	Resident	Visitor	
111	Lake County	31,637	23,387	67,519	17,951	140,494
112	Mendocino County	160,251	77,322	20,073	0	257,646
113	Merced County	63,196	29,871	0	1,257	94,325
114	Monterey County	374,341	758,509	109,063	153,517	1,395,431
115	Sacramento County	303,722	155,336	753,227	94,907	1,307,192
116	San Benito County	76,610	36,755	30,133	4,451	147,949
117	San Joaquin County	297,160	117,948	295,184	41,795	752,088
118	Santa Cruz County	765,929	525,957	164,123	46,364	1,502,372
119	Stanislaus County	254,757	136,775	224,504	5,709	621,745
120	Yolo County	0	8,192	1,380	0	9,572
131	Northern California	96,554	38,376	109,493	0	244,423
132	Sierra	229,175	130,803	260,045	9,481	629,503
133	Central Valley	81,736	104,416	68,433	0	254,585
134	Central Coast	37,081	37,655	2,759	0	77,495
135	Southern California	17,265	134,431	4,139	13,483	169,318
Total		2,789,416	2,315,731	2,110,075	388,915	7,604,136

Domestic Trips

Baseline Scenario Base Case Forecast – 2035

Superdistrict	Resident Trips		Visitor Trips		Total
	Home Origins	Other Origins	Home Origins	Other Origins	
1	952,854	876,832	596,970	8,472,206	10,898,862
2	1,062,923	115,892	462,269	809,986	2,451,070
3	1,350,558	209,863	445,366	144,562	2,150,348
4	502,072	107,323	145,435	40,701	795,532
5	909,165	192,270	233,043	899,594	2,234,073
6	857,179	122,438	301,618	683,356	1,964,590
7	650,137	97,500	239,904	360,336	1,347,876
8	974,768	172,733	341,066	617,962	2,106,529
9	1,209,433	514,989	436,251	1,004,245	3,164,918
10	662,783	85,142	273,961	209,947	1,231,833
11	1,621,002	354,493	871,564	1,035,168	3,882,227
12	464,510	120,105	181,252	101,711	867,578
13	822,546	100,969	224,732	81,610	1,229,858
14	372,846	90,025	221,581	190,559	875,011
15	1,002,499	122,823	317,930	460,340	1,903,592
16	696,017	100,333	309,412	267,787	1,373,550
17	814,335	88,905	259,764	219,294	1,382,298
18	2,180,440	504,563	831,272	1,204,287	4,720,562
19	1,226,571	197,282	380,336	474,150	2,278,338
20	704,661	47,427	148,948	156,304	1,057,340
21	676,837	58,672	183,596	274,102	1,193,208
22	589,100	128,589	205,899	208,835	1,132,423
23	516,374	37,079	114,047	173,065	840,565
24	606,700	26,162	169,739	32,837	835,438
25	470,783	39,527	114,552	61,062	685,925
26	318,970	28,112	71,051	64,711	482,843
27	211,053	13,693	74,980	294,783	594,509
28	68,854	5,622	30,836	255,552	360,865
29	460,063	67,967	155,696	250,184	933,910
30	633,549	101,701	144,804	314,506	1,194,560
31	173,853	22,490	92,294	92,488	381,124
32	199,289	41,805	48,941	39,618	329,653
33	365,831	81,660	150,888	206,013	804,391
34	333,765	36,182	122,486	201,291	693,724
Total Bay Area	24,662,320	4,911,168	8,902,483	19,903,153	58,379,123
External Zones	2,203,658	585,757	1,068,238	1,247,493	5,105,147
Total	26,865,979	5,496,925	9,970,721	21,150,646	63,484,270

Domestic Trips (cont.)

Baseline Scenario Base Case Forecast – 2035

External Zone		Resident Trips		Visitor Trips		Total
		Home Origins	Other Origins	Home Origins	Other Origins	
111	Lake County	26,015	5,622	3,762	19,625	55,024
112	Mendocino County	132,866	27,386	54,088	23,234	237,573
113	Merced County	49,504	13,693	23,389	6,482	93,068
114	Monterey County	315,485	58,856	246,287	512,222	1,132,850
115	Sacramento County	201,523	102,199	57,737	97,598	459,057
116	San Benito County	73,106	3,504	36,755	0	113,365
117	San Joaquin County	277,845	19,315	67,792	50,156	415,108
118	Santa Cruz County	701,751	64,178	292,603	233,354	1,291,886
119	Stanislaus County	199,259	55,498	82,115	54,660	391,532
120	Yolo County	0	0	0	8,192	8,192
131	Northern California	24,916	71,639	16,892	21,484	134,930
132	Sierra	154,362	74,813	39,738	91,065	359,978
133	Central Valley	26,964	54,772	17,127	87,289	186,152
134	Central Coast	6,978	30,102	24,691	12,964	74,736
135	Southern California	13,084	4,181	105,262	29,168	151,696
Total		2,203,658	585,757	1,068,238	1,247,493	5,105,147

International Trips

Baseline Scenario Base Case Forecast – 2035

Superdistrict	Resident Trips		Visitor Trips		Total
	Home Origins	Other Origins	Home Origins	Other Origins	
1	376,250	28,753	215,474	3,122,140	3,742,616
2	344,171	27,373	91,167	144,349	607,059
3	294,553	0	85,350	63,514	443,417
4	191,223	0	27,033	0	218,256
5	232,761	41,060	61,063	574,429	909,313
6	317,374	0	59,606	135,318	512,298
7	215,840	1,380	32,591	64,201	314,011
8	380,617	4,139	25,589	145,666	556,011
9	642,192	71,192	125,997	124,229	963,610
10	298,471	28,753	50,162	64,887	442,273
11	375,587	17,936	115,921	72,808	582,252
12	355,456	31,512	43,411	20,010	450,388
13	208,408	0	20,860	45,563	274,832
14	99,271	1,380	16,681	20,010	137,341
15	173,698	0	17,106	19,323	210,127
16	387,508	0	65,247	36,588	489,344
17	413,256	0	47,498	26,926	487,680
18	526,391	13,687	73,349	41,502	654,929
19	283,550	0	138,590	80,779	502,918
20	200,869	0	20,945	0	221,814
21	151,780	27,373	54,734	686	234,573
22	230,132	13,687	68,669	17,951	330,438
23	66,846	0	13,388	26,926	107,160
24	251,859	0	3,092	0	254,951
25	110,938	27,373	196,019	0	334,330
26	165,716	0	26,670	0	192,386
27	71,696	0	34,928	45,619	152,243
28	47,820	54,746	24,650	26,926	154,143
29	135,817	0	14,837	26,926	177,580
30	168,445	13,687	8,462	17,951	208,544
31	27,745	27,373	0	0	55,118
32	35,605	13,687	7,404	0	56,695
33	77,089	0	33,083	8,975	119,147
34	92,849	0	5,579	0	98,428
Total Bay Area	7,951,783	445,090	1,825,152	4,974,203	15,196,227
External Zones	1,588,605	521,469	215,691	173,224	2,498,990
Total	9,540,388	966,559	2,040,843	5,147,426	17,695,216

International Trips (cont.)

Baseline Scenario Base Case Forecast – 2035

External Zone		Resident Trips		Visitor Trips		Total
		Home Origins	Other Origins	Home Origins	Other Origins	
111	Lake County	67,519	0	0	17,951	85,470
112	Mendocino County	20,073	0	0	0	20,073
113	Merced County	0	0	1,257	0	1,257
114	Monterey County	109,063	0	41,695	111,823	262,581
115	Sacramento County	493,183	260,045	94,907	0	848,134
116	San Benito County	30,133	0	4,451	0	34,584
117	San Joaquin County	267,811	27,373	41,795	0	336,980
118	Santa Cruz County	136,749	27,373	5,658	40,705	210,486
119	Stanislaus County	209,438	15,066	5,709	0	230,213
120	Yolo County	1,380	0	0	0	1,380
131	Northern California	82,119	27,373	0	0	109,493
132	Sierra	164,239	95,806	9,481	0	269,526
133	Central Valley	0	68,433	0	0	68,433
134	Central Coast	2,759	0	0	0	2,759
135	Southern California	4,139	0	10,738	2,745	17,622
Total		1,588,605	521,469	215,691	173,224	2,498,990

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To: Project Management Team
Bay Area Regional Airport System Plan Analysis Update

From: Geoff Gosling

Date: January 4, 2010
Revised June 29, 2010

Subject: **High-Speed Rail Scenario Passenger Diversion**

This memo documents the assessment of the potential future diversion of air passengers at the Bay Area airports to the planned California high-speed rail (HSR) system. The High-Speed Rail Scenario forms one of several system development scenarios defined for the Target Analysis undertaken as part of the mid-point scenario screening in the current phase of the Bay Area Regional Airport System Plan Analysis (RASPAs) update. This scenario has the potential to reduce the number of passenger airline flights at each Bay Area airport compared to the Baseline scenario (which does not consider the effect of high-speed rail service on future travel growth) as some intra-California air passengers select HSR over airline service due to factors such as closer proximity of stations to their final destinations, train fares, train frequency, reliability of service, etc.

General Approach to Estimating Diversion of Air Passengers to High-Speed Rail

The estimated diversion of air trips to HSR is based on the forecasts of future ridership on the planned California HSR system prepared for the California High-Speed Rail Authority (CHSRA) and the Metropolitan Transportation Commission (MTC) by Cambridge Systematics, Inc. No independent estimates of potential HSR ridership have been developed as part of the RASPAs update. These forecasts are generally presented in terms of travel in inter-regional markets within the state based on fairly large regional areas, such as the Bay Area. These inter-regional forecasts then have to be adjusted to come up with the number of air passengers diverted to HSR at each of the three primary Bay Area commercial service airports.

The forecasts of future HSR ridership prepared for the CHSRA and MTC were based on an inter-regional travel demand model that projected future inter-regional trips within California by four modes: automobile, air, conventional rail, and high-speed rail (for cases where HSR service is available). By comparing the forecast number of air trips in the No-Build case (no HSR service available) in a given market with the corresponding forecast for a scenario that assumes some level of HSR service, the forecast percentage diversion of air travel to HSR in that market can be calculated. This diversion rate was then applied to the demand forecast for intra-California air travel in the relevant market prepared as part of the RASPAs update study.

Since the forecasts of air trips in a given inter-regional market prepared as part of the HSR ridership forecasts did not identify which airport those air passengers used, only that they used air travel, it was necessary to make assumptions about the way in which the overall diversion rate for the Bay Area as a whole varied across the three primary airports in the region.

Recent Forecasts of Future High-Speed Rail Ridership

The most recent forecasts of future HSR ridership were released by the CHSRA in a report to the California Legislature in December 2009.¹ These forecasts differed from earlier forecasts prepared in 2007 as part of a study undertaken for the Metropolitan Transportation Commission and the CHSRA² in three important respects:

- The forecast ridership and associated revenue assumed implementation of the Initial Phase of the planned California HSR system rather than the full system on which the earlier forecasts were based.
- The forecasts projected ridership in 2035, rather than 2030 used in the earlier forecasts.
- The forecasts assumed that HSR fares would be set to 83% of the comparable airfares, rather than 50% assumed in the earlier forecasts.

In addition, the results of the revised forecasts presented in the *Report to the Legislature* only provide forecasts of HSR ridership, not the corresponding use of other modes, and are at a somewhat more aggregate zonal level of detail than the summary results of the earlier forecasts prepared in 2007 that had been provided to the RASPA study team by Cambridge Systematics in the form of Microsoft Excel files. It was therefore necessary to use the more detailed results of the earlier forecasts to subdivide the latest forecasts of HSR ridership into a more detailed set of zones and estimate the corresponding use of other modes.

The Initial Phase of the planned HSR system comprises the route from San Francisco through the San Joaquin Valley to the Los Angeles basin, terminating at Anaheim, as shown in Figure 1. The latest ridership forecasts are based on a route alignment between the Bay Area and the Central Valley that uses the Pacheco Pass to the east of Gilroy. However, the CHSRA is currently addressing several environmental issues with this alignment as a result of a recent court case. This phase does not include the planned route between Merced and Sacramento or the planned route from Los Angeles to San Diego that were included in the full system analyzed in the 2007 *Ridership and Revenue Forecasting Study*. The implementation schedule presented in the December 2009 *Report to the Legislature* envisages that the Initial Phase will be operational by 2020. No dates have been established for completion of the subsequent sections of the planned HSR system shown in Figure 2.

The CHSRA's decision to base the revised ridership and revenue forecasts on assumed HSR fares of 83% of the corresponding airfares was based on an analysis that suggested that this fare level would generate the greatest revenue relative to operating costs. Although ridership would of course be less at the higher fare levels, the higher fares would largely offset the loss of revenue due to the lower ridership and the operating costs would be reduced by the need to carry fewer passengers.

¹ California High-Speed Rail Authority, *Report to the Legislature*, Sacramento, California, December 2009.

² Cambridge Systematics, Inc., *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study: Ridership and Revenue Forecasts*, Prepared for the Metropolitan Transportation Commission and the California High-Speed Rail Authority, Oakland, California, Draft Report, August 2007.

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Source: CHSRA, *Report to the Legislature*, December 2009, p.5.

Figure 1. Initial Phase of the Planned California High-Speed Rail System and Potential Station Locations

The forecast ridership by major market pairs is shown in Table 1. CHSRA projects a total ridership in 2035 of 41 million passengers, of which 11.9 million (or 29%) will be local intra-regional trips within either the Bay Area or the Los Angeles (LA) basin. Of the remaining 29.1 million interregional trips, the largest single market is between the Bay Area and the Los Angeles basin, which accounts for 7.9 million trips, or 19% of the total ridership. The market between the Bay Area and the San Diego region is projected to account for 2.0 million annual trips, or 25% of the ridership between the Bay Area and the Los Angeles basin. During the Initial Phase of the planned system, HSR riders from the San Diego area would have to use a car or conventional rail service to access the Anaheim station.

Despite somewhat long access distances from both regions to HSR stations, CHSRA forecasts 2.9 million annual HSR trips between the Monterey Bay and Central Coast regions and the Bay Area and Los Angeles basin.

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Source: CHSRA, *Report to the Legislature*, December 2009, p.5.

Figure 2. Subsequent Sections of the Planned California High-Speed Rail System

Table 1. Ridership and Revenues by Market, Initial Phase, 2035, Fares 83% of Air

Market Pairs (Ultimate trip ends)	Riders (millions)	Revenues (millions, 2009\$)
LA Basin – Bay Area, with intermediate markets	23.4	\$2,095
LA Basin- Bay Area	7.9	\$900
San Joaquin Valley - LA Basin	6.3	\$467
Bay Area - San Joaquin Valley	5.8	\$458
Monterey Bay /Central Coast - LA Basin & Bay Area	2.9	\$238
Within San Joaquin Valley	0.5	\$32
San Diego region - Bay Area	2.0	\$234
LA basin – Sacramento region	1.2	\$143
Other Inter-regional	1.5	\$86
North & Sierra regions - LA Basin	0.5	\$43
Sacramento region - San Joaquin Valley	0.5	\$42
Inter-regional subtotal	29.1	\$2,643
within LA basin	7.9	\$152
within Bay Area Peninsula	4.0	\$76
Local within-region subtotal	11.9	\$228
Total Initial Phase	41.0	\$2,871
Source: High-Speed Rail Authority Program Management Team, 2009		

Source: CHSRA, *Report to the Legislature*, December 2009, Table C.

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Because of the uncertainty of when the subsequent sections of the planned HSR system will become operational, it has been assumed that only the Initial Phase will be operational by 2035. Even if these subsequent sections become operational before 2035, they would have a relatively small impact on the diversion of Bay Area air trips to HSR, since the major market between the Bay Area and the Los Angeles basin is fairly well served by the Initial Phase. It can be expected that the HSR market share for travel between the Bay Area and the San Diego region would increase, as well as that for travel between the Bay Area and the eastern part of the Los Angeles basin served by the route from Los Angeles to San Diego. However, it is likely that the resulting change in the number of trips diverted from air to HSR would be fairly small, since these markets are much smaller than the Los Angeles basin market that is already well served by the Initial Phase and some diversion to HSR to/from these markets has already been included in the ridership forecasts for the Initial Phase.

Estimating Diversion from Air Travel to High-Speed Rail

The methodology used by Cambridge Systematics, Inc., to forecast HSR ridership did not explicitly model diversion from air or other modes to HSR. Rather, a statewide Interregional Travel Model System (ITMS) was used to project travel by all modes between zone pairs in a system of travel analysis zones covering the entire state. The trips between any zone pair were calculated using trip generation and trip distribution relationships that were estimated from household travel survey data. This resulted in a zone-to-zone trip table that differentiated trips by four trip purposes: business, commute, recreational, and other trips. Then a mode choice model was used to assign inter-regional trips to four primary travel modes: car, air, conventional rail, and high-speed rail (depending on whether conventional rail service is available for a given zone pair, and whether high-speed rail is included in the analysis scenario). The mode choice model was estimated on a combination of revealed preference and stated preference travel survey data. The ITMS was calibrated for trips involving car, air or conventional rail using travel data for the year 2000. The details of the ITMS have been documented in reports prepared for the 2007 Ridership and Revenue Forecasting Study.^{3,4}

Intra-regional trips within the Bay Area and Southern California were not modeled using the ITMS. Instead, the existing regional travel models developed and maintained by the Metropolitan Transportation Commission and the Southern California Association of Governments were used to forecast intra-regional HSR ridership by adding the planned HSR service to the modes available in the regional models. Of course, none of the intra-regional trips involve air travel, so these trips do not affect the diversion from air to HSR.

Although the ITMS does not explicitly model the diversion of air trips to HSR, the diversion rate for each major market can be inferred by comparing the number of air trips

³ Cambridge Systematics, Inc., with Mark Bradley Research and Consulting, *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study: Interregional Model System Development*, Prepared for the Metropolitan Transportation Commission and the California High-Speed Rail Authority, Oakland, California, Draft Report, August 2006.

⁴ Cambridge Systematics, Inc., *et al.*, *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study: Draft Final Report*, Prepared for the Metropolitan Transportation Commission and the California High-Speed Rail Authority, Oakland, California, July 2007.

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forecast by the ITMS for the No-Build scenario with the corresponding number of air trips in the relevant HSR scenario. This diversion rate can then be applied to the forecast number of air trips in the major market (e.g., Bay Area to LA Basin) in the RASPA Base Case forecast to estimate the potential Bay Area diversion to HSR in that market. In considering the results of applying this approach, there are a number of factors that should be borne in mind:

1. The results of the ITMS show the mode use for a given zone pair, without considering which airports were used by air trips between the zone pair. Thus air trips between Modesto and Los Angeles (for example) would be reported as travel between the Central Valley and the Los Angeles basin, although the travelers might actually have used one of the Bay Area airports.
2. For the same reason, the allocation of air trips to and from the Bay Area to the Bay Area airports has to be done outside of the ITMS results.
3. The RASPA Base Case forecast does not explicitly project future regional air travel in a given market by airport. Rather it forecasts the growth in total regional air travel in a given market. It is therefore necessary to estimate how this regional demand will be distributed among the airports in order to calculate the HSR diversion rate by airport.
4. The RASPA Base Case forecast does not explicitly project future regional air travel in a given market by trip purpose. Therefore it is implicitly assumed that the trip purpose composition of travel in a given market in the RASPA Base Case forecast is the same as that given for air trips in the ITMS.

The December 2009 *Report to the Legislature* includes a discussion of the ridership forecasting methodology but does not provide a more detailed zonal breakdown of the forecast ridership shown in Table 1 or the forecast use of other modes that corresponds to the forecast HSR ridership. However, in September 2009, Cambridge Systematics provided a number of Microsoft Excel files summarizing the details of various earlier forecasts, and we have used this information to develop our HSR diversion estimates. The forecasts that we have relied on for this analysis include:

- A 2030 No-Build scenario.
- A 2030 HSR alternative scenario for the full system using the Pacheco Pass route with HSR fares assumed at 50% of corresponding airfares.
- A 2035 HSR alternative scenario for the Initial Phase using the Pacheco Pass route with HSR fares assumed at 50% of corresponding airfares. The analysis for this scenario appears to have been done subsequent to the earlier work for the 2030 scenarios, but still does not address the change in fare assumptions in the 2009 *Report to the Legislature*.

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The Excel files provided more geographic detail than the latest forecasts shown in Table 1 above. In particular, they subdivided the Los Angeles Basin into two regions, North LA Basin and South LA Basin, and the files for the 2030 No-Build Scenario and the 2030 full system HSR alternative provided separate results for travel between each of the regions. This allowed the HSR trips shown in Table 1 to be subdivided into the following sub-regional markets:

- Bay Area to LA Basin (North)
- Bay Area to LA Basin (South)
- Monterey Bay to San Joaquin Valley
- Monterey Bay to LA Basin (North)
- Monterey Bay to LA Basin (South)
- Monterey Bay to San Diego
- San Joaquin Valley (North) to LA Basin (North)
- San Joaquin Valley (North) to LA Basin (South)
- San Joaquin Valley (North) to San Diego.

The division of the San Joaquin Valley to the LA Basin and San Diego regional markets into the separate sub-regional markets of San Joaquin Valley (North) comprising San Joaquin, Stanislaus and Merced counties and San Joaquin Valley (South) comprising the remainder of the valley, allows the air passenger diversion analysis to reflect the potential use of the Bay Area airports by trips to Southern California from counties in the north of the valley. Trips to Southern California from the counties in the south of the valley are unlikely to travel north to the Bay Area in order to take flights back south to airports in Southern California. Rather those trips to Southern California using air from these counties will fly from the airports in the valley.

The use of the other modes (including air) in each of the regional markets in the 2035 scenario that assumed HSR fares at 83% of airfares (for which forecasts of the use of other modes was not provided) was estimated from the proportional use of those modes in the 2035 scenario that assumed HSR fares at 50% of airfares (for which the forecast use of other modes *was* given). Since the relative service levels of the other modes are unaffected by the HSR fares, it can be expected that their proportional use relative to all non-HSR trips in each market will remain unchanged.

Since the sub-regional markets are not shown in Table 1, the number of HSR trips in each of those markets in 2035 was estimated from the 2030 full system HSR alternative by assuming that the percentage of HSR trips in a given regional market in each of the component sub-regional markets in 2035 remains the same as the percentages of 2030 HSR trips in the corresponding sub-regional markets. The HSR service in the Initial Phase and the full system is essentially the same for each of the sub-regional markets listed above with the exception of San Joaquin Valley (North) and Monterey Bay to San Diego, so it seems reasonable that the 2035 HSR trips in the various sub-regional markets apart from these two sub-regional markets would

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retain the same proportions as in 2030 for the full system at the lower fare level. Similarly, although the HSR service in the Initial Phase and the full system is different for the regional market between the San Joaquin Valley and San Diego, it seems likely that the difference would have a similar effect on HSR ridership in the San Joaquin Valley (North) and San Joaquin Valley (South) to San Diego sub-regional markets. Therefore it seems reasonable to assume that the percentage of HSR trips in the two sub-regional markets would be the same in the 2035 and 2030 scenarios.

The sub-regional market between Monterey Bay and San Diego is a more complicated situation because the forecast HSR ridership in the regional market between Monterey Bay/Central Coast and San Diego is not shown in Table 1, but is included in “Other inter-regional” markets. Therefore the 2035 HSR trips for the Monterey Bay to San Diego sub-regional market were estimated by assuming that the HSR share of total trips by all modes would change from the share in 2030 for the full system in proportion to the corresponding change in the HSR share for the Bay Area to San Diego, while the total number of trips between Monterey Bay and San Diego in 2035 would increase from the 2030 No-Build Scenario in proportion to the growth in total statewide inter-regional trips from 2030 to 2035, where the total number of inter-regional trips in 2035 was given by the 2035 scenario that assumed HSR fares at 50% of airfares.

Similarly, for each of the sub-regional markets (not shown in Table 1) the number of trips by other modes (including air) in 2035 with HSR fares assumed at 83% of airfares was estimated from the proportional use of those modes in the 2030 full system scenario with HSR fares assumed at 50% of airfares, since the relative service levels of the other modes are unaffected by the HSR fares or the extent of the HSR system. This gave estimates of the number of air trips in each market and sub-regional market in 2035 for the Initial Phase with HSR fares assumed at 83% of airfares. Hence the HSR diversion in each market was calculated by comparing the number of air trips in the 2035 Initial Phase scenario with the number of air trips in the 2030 No-Build Scenario extrapolated to 2035 by assuming that the mode use in each market remained constant and the total trips in each market increased in proportion to the growth in total inter-regional trips from 2030 to 2035.

This gave the following percentage diversion of air trips to HSR for each market in 2035:

- Bay Area to San Joaquin Valley 54.4%
- Bay Area to LA Basin (North) 63.1%
- Bay Area to LA Basin (South) 53.4%
- Bay Area to San Diego 19.0%
- Monterey Bay to San Joaquin Valley 44.4%
- Monterey Bay to LA Basin (North) 37.9%
- Monterey Bay to LA Basin (South) 21.3%
- Monterey Bay to San Diego 7.8%
- San Joaquin Valley (North) to LA Basin (North) 25.2%

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- San Joaquin Valley (North) to LA Basin (South) 18.8%
- San Joaquin Valley (North) to San Diego 1.4%

External Markets

Air travel to and from the Bay Area airports includes trips from origins or to destinations in the Bay Area as well as trips that begin or end at counties outside the Bay Area but use ground transportation to travel to or from the airports. From the perspective of diversion of Bay Area air trips to HSR, the two external regions of particular concern are the Monterey Bay region, comprising Monterey, San Benito and Santa Cruz counties, and the three counties that form the North San Joaquin Valley region (San Joaquin, Stanislaus and Merced). Given the level of air service between Sacramento International Airport and airports in Southern California it is unlikely that many air travelers between the Sacramento region and markets served by the planned HSR system would use Bay Area airports. Both the Monterey Bay and North San Joaquin Valley regions will be served by HSR in the Initial Phase, with trips to and from the Monterey Bay region having fairly good access to the HSR system at Gilroy, south of San Jose, and trips to and from the North San Joaquin Valley region having fairly good access to the Initial Phase of the HSR system at Merced. In each case, the HSR stations will be significantly closer than any of the Bay Area airports. Therefore air trips from these regions that would otherwise use the Bay Area airports (due to limited air service to Southern California airports at Monterey Peninsula Airport or the North San Joaquin Valley airports or lower airfares in these markets at Bay Area airports) are likely to experience significant diversion to HSR.

For both the Monterey Bay and North San Joaquin Valley regions, air trips to and from the LA Basin and San Diego can use one of three options:

- Flights between the local airport and Los Angeles International Airport (LAX), with possibly a connecting flight at LAX
- Flights between the local airport and San Francisco International Airport (SFO) with a connecting flight to or from an airport in Southern California
- Ground travel to and from one the Bay Area airports (generally SFO and San Jose International Airport (SJC) for the Monterey Bay region and all three Bay Area airports for the North San Joaquin Valley region).

There is likely to be less use of connecting flights at SFO for travel to or from Southern California than direct flights to LAX, since each of the local airports in the external regions generally has as good air service to LAX as to SFO, so the use of SFO would often involve significantly longer travel time. However, the choice of a connecting route depends on more factors than just the travel time, including the available airfares on the different routes, seat availability on particular flights, and how well the flight schedules match the desired departure time. Thus situations will arise in which air travelers may choose to take a longer route. In cases where the trip end in Southern California is better served by another airport than LAX, there may be little difference in overall travel time between connecting at SFO or LAX, and indeed some Southern California airports may not have air service to and from LAX.

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Determining the split of air trips between the above three options would ideally involve a fairly detailed model of air service economics and airport choice, although such an analysis is beyond the scope of the current study. Therefore it was necessary to make assumptions about the proportion of trips using each of the three options, as shown in Table 2. Although these assumptions are essentially educated guesses, the overall level of air travel to and from the external regions is so small that even significant errors in the assumptions would have very little effect on the forecast number of air passengers at Bay Area airports likely to be diverted to HSR.

Table 2. Assumed Use of Bay Area Airports by Air Trips from External Regions, 2020 and 2035

Market	Use of Bay Area Airports		To/from or Connect via LAX
	Ground Access/Egress	Connect via SFO	
Monterey Bay – San Joaquin Valley	20%	20%	60%
Monterey Bay – LA Basin (North)	40%	20%	40%
Monterey Bay – LA Basin (South)	40%	25%	35%
Monterey Bay – San Diego	45%	25%	30%
San Joaquin Valley (North) – LA Basin (North)	40%	20%	40%
San Joaquin Valley (North) – LA Basin (South)	40%	25%	35%
San Joaquin Valley (North) – San Diego	45%	25%	30%

These assumptions reflect the shorter travel times for direct flights to LAX or connecting flights through LAX compared to connecting flights through SFO. It is unlikely that trips between the Monterey Bay region and the north of the San Joaquin Valley would use air travel, so most air trips in this market would be to the south of the valley, where connecting flights through LAX would involve significantly shorter travel times than through SFO. It is also unlikely that travelers between either of the two external regions and the LA basin would take connecting flights at LAX to other airports. Therefore many such travelers might find direct flights between one of the Bay Area airports and one of the secondary airports in the LA basin more convenient than the longer access and egress times to and from LAX. Similarly, direct flights between one of the Bay Area airports and San Diego would offer an even greater time advantage than for trips to and from the south of the LA basin.

Combined Diversion of Bay Area and External Trips to High-Speed Rail

The Bay Area air trips projected by the HSR ridership forecasts prepared for the CHSRA only include trips beginning or ending in the nine-county Bay Area. Therefore to project the diversion to HSR of air trips using the Bay Area airports, it is necessary to combine the forecast air trips to and from the Bay Area with the air trips to and from external markets that use ground transportation to access one of the Bay Area airports or their final destination in the external

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region (a much smaller universe of air passengers, but nevertheless there would be an effect on the overall Bay Area diversion to HSR, as shown below).

Because the trips from the external regions generally had a lower percentage diversion to HSR than trips to and from the Bay Area, this reduced the overall percentage diversion of air trips in the California Corridor between the Bay Area airports and Southern California in 2035 as follows:

- | | |
|---|-------|
| • Bay Area airports to LA Basin (North) | 60.1% |
| • Bay Area airports to LA Basin (South) | 46.5% |
| • Bay Area airports to San Diego | 18.8% |

Diversion of Connecting Passengers

In addition to the diversion to HSR of air passengers to and from Southern California from the Monterey Bay and North San Joaquin Valley external regions who would otherwise connect at SFO, air passengers from the Monterey Peninsula Airport or airports in the San Joaquin Valley who are connecting at SFO to or from flights in other markets could use the HSR system to travel to and from SFO, thereby reducing the number of passengers on the regional airline flights between those external airports and SFO. This potential use of the HSR system does not appear to have been considered in the ridership forecasts prepared for the CHSRA.

Any such diversion to HSR would depend on the airline fare structure for connecting traffic, as well as such factors as the availability of through ticketing on the HSR services. Obviously, if the airfare charged for an itinerary on a connecting flight from an external airport is not significantly different from the airfare to the same destination from SFO, there will be no incentive to use HSR to access SFO. However, the airlines could reduce their costs of operating connecting flights to and from the external airports while retaining the fare revenue for the remainder of the connecting itineraries by adopting fare policies that encourage the use of HSR to access SFO or SJC. Potential diversion percentages were estimated under the assumption that the HSR fare would be 83% of the incremental airfare for the local connecting segment. The diversion percentage for connecting trips that would otherwise use the San Joaquin Valley airports was assumed the same as for other trips between the Bay Area and San Joaquin Valley. The diversion percentage for Monterey Peninsula Airport was set to half of the diversion rate for the San Joaquin Valley airports, due to the greater distance needed to access the HSR service from the Monterey Bay region.

This gave the reduction in connecting passengers at SFO shown in Table 3.

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Table 3. Potential Reduction in Connecting Passengers at SFO in 2035

Market/Airport	Connecting Passengers	Diversion to HSR	Diverted HSR Trips	Remaining Air Trips
<i>Domestic Trips</i>				
Bakersfield	37,000	54.4%	20,000	17,000
Fresno-Yosemite	95,000	54.4%	52,000	43,000
Modesto	98,000	54.4%	53,000	45,000
Monterey Peninsula	110,000	27.7%	30,000	80,000
Total	339,000		155,000	184,000
<i>International Trips</i>				
Bakersfield	6,000	54.4%	3,000	3,000
Fresno-Yosemite	47,000	54.4%	25,000	21,000
Modesto	9,000	54.4%	5,000	4,000
Monterey Peninsula	21,000	27.7%	6,000	15,000
Total	83,000		39,000	43,000
Total	422,000		194,000	228,000

Note: Totals may not sum due to rounding

Diversion to High-Speed Rail in 2020

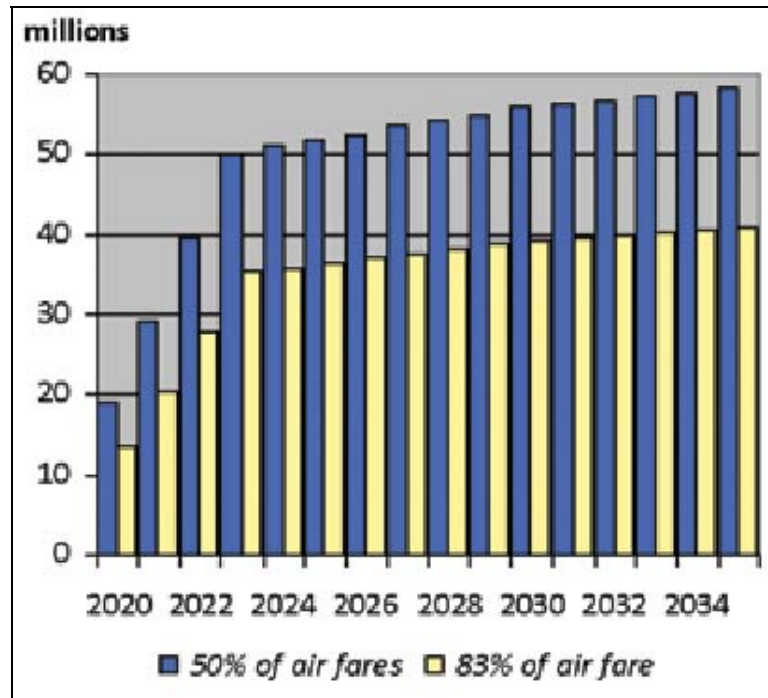
It can be expected that the diversion of air trips to HSR will be much less in the first few years after HSR service begins than in later years. The RASPA Base Case forecast provides regional market-level forecasts of future air passengers for 2020 and 2035. As it happens, 2020 is also the first year of service on the complete Initial Phase of the HSR system according to the implementation schedule given in the CHSRA December 2009 *Report to the Legislature*.

The *Report to the Legislature* forecasts the growth in total HSR riders by year from 2020, as shown in Figure 3. The growth in total ridership from year to year has been estimated from start-up experience with other high-speed rail systems elsewhere in the world. This gives a total ridership of 13.5 million passengers in 2020 and 41.0 million passengers in 2035. Thus it is not possible to derive a different distribution of HSR riders by market for earlier years than 2035, and it has been assumed that the HSR diversion rates for 2035 by market are simply reduced in proportion to the projected total HSR ridership for earlier years.

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Source: CHSRA, *Report to the Legislature*, December 2009, Figure 1, p.71.

Figure 3. Forecast Growth in California High-Speed Rail Riders Over Time

Diversion to High-Speed Rail by Airport

The above HSR diversion analysis by market considers the Bay Area as a single region. Thus there are two aspects to calculating the diversion of air trips to HSR for each of the Bay Area airports:

1. Projecting the share of total regional traffic in a given market that will be handled by each airport (e.g., SFO to LAX, SJC to LAX, etc.)
2. Estimating the HSR diversion rate in a given market at each airport (e.g., the percentage of air passengers in the SFO-LAX market diverted to HSR).

In assessing the number of air passengers in a given airport-pair market that could potentially be diverted to HSR, with the exception of the connecting passengers at SFO from the external airports served by the HSR system discussed above it is assumed that only those passengers beginning and ending their air trip at the airports in question would consider using HSR. These are usually referred to as origin-destination (O&D) passengers.

The assumed distribution among the three primary Bay Area airports of the forecast 2035 O&D passenger traffic between the Bay Area and a given airport in Southern California was derived from a review of recent trends in market share between the three airports and the

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associated airline service changes. The resulting assumptions are necessarily based on professional judgment, recognizing that it is very difficult to predict future airline decisions, as history has evidenced. In some cases the recent trends were assumed to continue or stabilize. In other cases they were assumed to reverse as recent cuts in air service are restored in the future or current airline competition for market share abates. The airport market shares shown in Table 4 were derived on the basis of the following assumptions:

1. The recent growth in the SFO share of traffic in the LAX market due to intense airline competition and the entry of new carriers was assumed to reverse to the regional shares for each airport experienced in 2007.
2. The recent growth in the SFO share of traffic in the Orange County Airport (SNA) market was assumed to continue to just short of an equal share with OAK and SJC.
3. The recent decline in the SFO share of traffic in the Burbank Airport (BUR) market was assumed to reverse, with a growth in the SFO share to approximately twice the share experienced in 2006, while the recent growth in the SJC share of the regional traffic was assumed to continue to a level slightly higher than the share experienced in 2008.
4. The recent decline in the SFO share of traffic in the Ontario International Airport (ONT) market was assumed to reverse, with a growth in the SFO share to slightly more than twice the share experienced in 2006, while the SJC share of the regional traffic was assumed to stabilize at a level around that experienced in 2008.
5. The recent growth in the SFO and SJC shares of traffic in the Long Beach Airport (LGB) market was assumed to continue, with SFO reaching the same share as OAK and the SJC share stabilizing at a level slightly below the OAK and SFO shares.
6. SFO would continue to dominate the Palm Springs Airport (PSP) market, but the recent growth in the SJC share of the market was assumed to continue, to reach a level about 50% above the level in 2009, while the recent decline in the OAK share of the market was assumed to reverse and grow to a level equal to the SJC share of the market in 2009.
7. The recent growth in the SFO share of the San Diego International Airport (SAN) market was assumed to reverse and stabilize at the level experienced in 2008, with OAK and SJC experiencing equal shares.

Identifying an appropriate HSR diversion rate for a given airport pair needs to consider any differences in the diversion rate between airports in the Bay Area as well as the relevant Southern California market diversion rate to use, where each of the Southern California airports was assigned to the appropriate sub-region (North LA Basin, South LA Basin or San Diego) and the diversion rate for that sub-regional market assigned to that airport. It was assumed that airport pair markets involving BUR and LAX would experience the diversion rate for the North

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LA Basin market, while those involving SNA and LGB would experience the diversion rate for the South LA Basin market. Airport pair markets involving ONT and PSP were assumed to experience the same diversion rate as the San Diego market, due to the relatively long access distances to the HSR stations in the Initial Phase. It was further assumed that the diversion rate in a given market at OAK would be 75% of the corresponding diversion rate at SFO and SJC, due to the greater distance of the primary OAK market area from the planned HSR stations. Since the overall regional diversion rate in a given market (e.g., the Bay Area to LAX) depends on the diversion rate at each airport as well as the market share of each airport, the diversion rates at each airport were calculated to maintain the desired relationship between the diversion rates at each airport while ensuring that the overall regional diversion rate was correct.

Table 4. Assumed Distribution of California Corridor Traffic Among the Bay Area Airports, 2020 and 2035

Airport Market		OAK	SFO	SJC
LAX	Los Angeles International	35%	40%	25%
SNA	Orange County	34%	32%	34%
BUR	Burbank	45%	20%	35%
ONT	Ontario International	45%	20%	35%
LGB	Long Beach	35%	35%	30%
PSP	Palm Springs	10%	75%	15%
SAN	San Diego International	30%	40%	30%

Combining the two considerations (the regional share of the traffic in each airport-pair market handled by each of the Bay Area airports and the diversion rate to HSR in each of these markets) gave the resulting 2035 diversion rate by airport-pair market shown in Table 5.

Table 5. 2035 Diversion to High-Speed Rail by Market
HSR Initial Phase, Fares 83% of Corresponding Airfares

Airport Market		OAK	SFO	SJC
LAX	Los Angeles International	49.4%	65.8%	65.8%
SNA	Orange County	38.1%	50.8%	50.8%
BUR	Burbank	50.8%	67.7%	67.7%
ONT	Ontario International	15.9%	21.2%	21.2%
LGB	Long Beach	38.2%	50.9%	50.9%
PSP	Palm Springs	14.5%	19.3%	19.3%
SAN	San Diego International	15.3%	20.3%	20.3%

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The corresponding diversion rates for 2020 are shown in Table 6, assuming that the number of air trips diverted to HSR in each market is reduced in proportion to the reduction in total HSR trips compared to 2035.

Table 6. 2020 Diversion to High-Speed Rail by Market
HSR Initial Phase, Fares 83% of Corresponding Airfares

Airport Market		OAK	SFO	SJC
LAX	Los Angeles International	16.3%	21.7%	21.7%
SNA	Orange County	12.5%	16.7%	16.7%
BUR	Burbank	16.7%	22.3%	22.3%
ONT	Ontario International	5.2%	7.0%	7.0%
LGB	Long Beach	12.6%	16.8%	16.8%
PSP	Palm Springs	4.8%	6.4%	6.4%
SAN	San Diego International	5.1%	6.8%	6.8%

Resulting Diversion to High-Speed Rail by Airport

Applying the assumed distribution of California Corridor traffic among the Bay Area airports by airport-pair market (Table 4) to the forecast passenger traffic in each market at a regional level from the RASPA Base Case forecast gives the projected passenger traffic in each airport-pair market in 2020 and 2035 shown in Tables 7 and 8.

Table 7. Base Case 2020 Forecast Passengers by California Corridor Market

Airport Market		OAK	SFO	SJC	Total
LAX	Los Angeles International	1,291,000	1,476,000	922,000	3,690,000
SNA	Orange County	713,000	671,000	713,000	2,097,000
BUR	Burbank	780,000	347,000	607,000	1,734,000
ONT	Ontario International	505,000	224,000	393,000	1,122,000
LGB	Long Beach	166,000	166,000	142,000	474,000
		3,456,000	2,884,000	2,777,000	9,117,000
PSP	Palm Springs	21,000	156,000	31,000	208,000
SAN	San Diego International	886,000	1,182,000	886,000	2,955,000
Total		4,363,000	4,222,000	3,695,000	12,280,000

Note: Totals may not sum due to rounding

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Table 8. Base Case 2035 Forecast Passengers by California Corridor Market

Airport Market		OAK	SFO	SJC	Total
LAX	Los Angeles International	1,463,000	1,671,000	1,045,000	4,179,000
SNA	Orange County	840,000	790,000	840,000	2,469,000
BUR	Burbank	820,000	365,000	638,000	1,823,000
ONT	Ontario International	486,000	216,000	378,000	1,081,000
LGB	Long Beach	193,000	193,000	165,000	550,000
		3,801,000	3,235,000	3,066,000	10,102,000
PSP	Palm Springs	25,000	186,000	37,000	248,000
SAN	San Diego International	1,067,000	1,423,000	1,067,000	3,558,000
Total		4,894,000	4,844,000	4,170,000	13,908,000

Note: Totals may not sum due to rounding

Applying the foregoing diversion rates by airport-pair markets to the corresponding O&D passenger traffic forecast for each market, the resulting diversion to HSR of air travel between the Bay Area airports and Southern California airports in 2035 by airport is shown in Table 9.

Table 9. Diversion of 2035 California Corridor Passengers to High-Speed Rail

Base Case Forecast – HSR Initial Phase, Fares 83% of Corresponding Airfares

	OAK	SFO	SJC
California Corridor O&D Passengers	4,894,000	4,844,000	4,170,000
O&D Passengers Diverted to HSR	1,776,000	2,218,000	1,935,000
Undiverted O&D Passengers	3,118,000	2,626,000	2,235,000
Percent Diversion	36.3%	45.8%	46.4%

Including the assumed diversion of connecting passengers at SFO and comparing the diversion of air trips projected for 2020 and 2035 to the total forecast passengers at each airport gives the overall diversion rates shown in Table 10.

The results show that the potential diversion in 2035 is fairly modest, ranging from only about 4% of total passengers at SFO to about 12% at SJC. The low diversion rate at SFO is due to the California Corridor traffic and connecting passengers in markets that would be served by the HSR system forming a relatively small share (about 8%) of the total traffic at the airport. Naturally, the diversion rates are even lower in 2020.

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Table 10. Diversion of Bay Area Airport Passengers to High-Speed Rail in 2020 and 2035

Base Case Forecast – HSR Initial Phase, Fares 83% of Corresponding Airfares

	OAK	SFO	SJC
2020			
Total Annual Passengers	16,332,000	46,124,000	12,851,000
O&D Passengers Diverted to HSR	523,000	643,000	568,000
Connecting Passengers Diverted to HSR		48,000	
Undiverted Passengers	15,809,000	45,433,000	12,283,000
Percent Diversion	3.2%	1.5%	4.4%
2035			
Total Annual Passengers	20,655,000	64,356,000	16,305,000
O&D Passengers Diverted to HSR	1,776,000	2,218,000	1,935,000
Connecting Passengers Diverted to HSR		194,000	
Undiverted Passengers	18,880,000	61,945,000	14,371,000
Percent Diversion	8.6%	3.7%	11.9%

Sensitivity Analysis

A number of factors could cause a higher diversion of air passenger trips to HSR than implied by the most recent HSR ridership forecasts prepared by the CHSRA. These forecasts were based on the assumption that HSR fares would be 83% of equivalent airfares. However, future increases in fuel prices or other airline costs relative to the costs implied by the airfare assumptions in the latest HSR forecasts could reduce the HSR fares relative to airfares. Increasing levels of air traffic delay at SFO or Southern California airports could result in the dependability of HSR travel times attracting more riders. Finally, travelers may come to value the greater comfort and longer blocks of uninterrupted time offered by HSR travel more than suggested by the stated preference survey results on which the ridership forecasts are based.

In addition, by 2035 it is possible that the full planned HSR system, or at least the extension to San Diego, would be completed. From the perspective of diversion of Bay Area air passengers to HSR, the extension of the system to San Diego would offer almost all the additional diversion of the full system, since extension of the system to Sacramento is likely to result in very little diversion of air trips between the Bay Area airports and the Sacramento region to HSR, both due to the limited number of such trips and the rather circuitous HSR route between Sacramento and the Bay Area. Although the CHSRA 2009 *Report to the Legislature* did not provide an estimate of when subsequent sections beyond the Initial Phase would be completed, it did indicate that the current implementation schedule would have the Initial Phase completed by 2020. Given that this schedule has the much larger Initial Phase completed in ten

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years, it is not implausible that at least the section to San Diego could be completed in the following 15 years.

In order to assess how a higher diversion of air passenger trips to HSR could affect the foregoing results, a sensitivity analysis was performed for 2035 based on the earlier forecasts prepared for the CHSRA that were based on the full planned system rather than just the Initial Phase and that assumed that HSR fares would be 50% of corresponding airfares rather than 83% of corresponding airfares assumed in the latest forecasts. Since this was the HSR scenario for which the more detailed forecasts of mode use were available which were used to estimate the diversion rates from air travel to HSR for the sub-regional markets for the latest forecasts, it was a relatively simple matter to repeat the above analysis with the revised HSR fare and system assumptions.

The following tables present the resulting projected diversion rates and number of passengers diverted to HSR under the revised fare and system development assumption:

Table 11. 2035 Diversion to High-Speed Rail by Market
HSR Full System, Fares 50% of Corresponding Airfares

Airport Market		OAK	SFO	SJC
LAX	Los Angeles International	54.6%	72.9%	72.9%
SNA	Orange County	45.8%	61.1%	61.1%
BUR	Burbank	56.2%	74.9%	74.9%
ONT	Ontario International	47.3%	63.0%	63.0%
LGB	Long Beach	46.0%	61.3%	61.3%
PSP	Palm Springs	26.1%	34.8%	34.8%
SAN	San Diego International	27.5%	36.7%	36.7%

Table 12. Diversion of 2035 California Corridor Passengers to High-Speed Rail
Base Case Forecast – HSR Full System, Fares 50% of Corresponding Airfares

	OAK	SFO	SJC
California Corridor O&D Passengers	4,894,000	4,844,000	4,170,000
O&D Passengers Diverted to HSR	2,263,000	2,814,000	2,496,000
Undiverted O&D Passengers	2,631,000	2,030,000	1,674,000
Percent Diversion	46.2%	58.1%	59.9%

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Table 13. Diversion of Bay Area Airport Passengers to High-Speed Rail in 2035

Base Case Forecast – HSR Full System, Fares 50% of Corresponding Airfares

	OAK	SFO	SJC
Total Annual Passengers	20,655,000	64,356,000	16,305,000
O&D Passengers Diverted to HSR	2,263,000	2,814,000	2,496,000
Connecting Passengers Diverted to HSR		208,000	
Undiverted Passengers	18,392,000	61,334,000	13,809,000
Percent Diversion	11.0%	4.7%	15.3%

Comparison with European Experience with Diversion of Air Travel to High-Speed Rail

In discussions about the estimated potential diversion of Bay Area air passenger trips to HSR, the RASPA Task Force raised the question of how the forecast diversion rates implied by the CHSRA forecasts compared to the experience with the introduction of HSR in other countries. In 2006 the British consulting firm Steer Davies Gleeve (SDG) undertook a study for the European Commission that examined the rail market share compared to air travel in a number of European city-pair markets where high-speed rail had been introduced.⁵ Among other comparisons, the study calculated the rail market share (the percentage of trips by rail or air that used rail) in relation to the difference between the generalized journey time by both modes, where the generalized journey time included time required for check-in at the airport or rail station (including any security screening) and an allowance for differences in service frequency. Although the SDG report recognized that market share is also influenced by other factors, including relative access times and costs to airports and rail stations and differences in fare, and presented comparative data for these factors, they are not included in the generalized travel times used in the comparison of market share.

The results of this analysis are shown in Figure 4, where each data point shows the rail market share and excess generalized rail journey time over air travel for a given city-pair. For many of the markets, data was obtained for two years (shown for each data point) reflecting changes in rail service that had occurred between the two years. SDG also fitted a functional relationship to the data, as shown in Figure 4.

In order to compare these results with the ridership forecasts prepared for the CHSRA, the corresponding generalized excess journey time was calculated for an HSR trip from San Francisco to Los Angeles Union Station. This was based on the air travel and HSR level of service data given in the Excel summary files for the ridership forecast for the full system with HSR fares of 50% of corresponding air fares (the forecast scenario for which the most detailed results were available), using the air travel level of service data for flights between SFO and LAX. The assumed HSR in-vehicle time from downtown San Francisco to Los Angeles Union

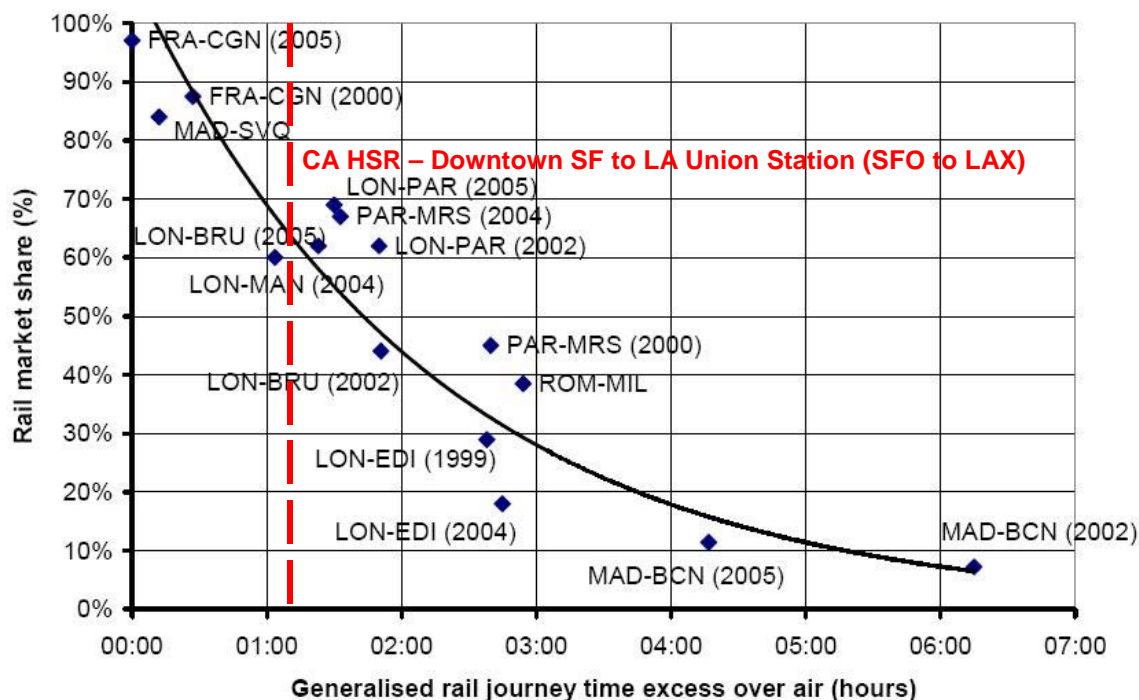
⁵ Steer Davies Gleeve, *Air and Rail Competition and Complementarity*, Report Prepared for the European Commission DG TREN, London, August 2006.

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Station shown in the Excel file (184 minutes) was somewhat higher than the fastest projected scheduled run times given in the 2009 *Report to the Legislature*, which showed seven different operating patterns between downtown San Francisco and Los Angeles Union Station with different intermediate stops and a range of run times between 160 minutes and 194 minutes. There was no effective difference in the headways for air and HSR shown in the Excel file (9 minutes and 8 minutes respectively). In order to calculate the excess journey time it was assumed that air passengers would need to arrive at the airport 60 minutes before flight departure while HSR passengers would need to arrive at the rail station only 20 minutes before train departure. This resulted in an excess generalized journey time by HSR of 69 minutes.



Source: Base figure from Steer Davies Gleeve, *Air and Rail Competition and Complementarity*, 2006, Figure 2.7.

Figure 4. Forecast Growth in California High-Speed Rail Riders Over Time

From the relationship shown in Figure 4, this would give a rail market share of about 65%. For comparison, the HSR market share of air and rail trips for the Bay Area to Los Angeles market in the ridership forecast for the full system with HSR fares of 50% of corresponding air fares is about 77%, while that for the ridership forecast for the Initial Phase with HSR fares of 83% of corresponding air fares is about 62%. Therefore it would appear that the HSR ridership forecasts prepared for the CHSRA are largely consistent with market share experience with high-speed rail services in Europe.

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However, it should be noted that the relationship between rail market share and excess rail journey time over air travel from the SDG report and its application to the California Corridor market does not consider access and egress times and costs to airports and rail stations nor differences in fare between air and rail. These are obviously important factors in the choice between rail and air for any given journey, but are difficult factors to represent in a market comparison of this type due to the different urban forms in the various cities, the differing relative locations of the airports and rail stations with respect to the pattern of trip ends, and the range of fares in a given market. The use of yield management systems by both airlines and rail service operators results in a wide range of fares for the same journey, depending on the time and day of travel, how far in advance of the trip the ticket was purchased, and what restrictions the travelers were willing to accept on their ability to change their travel plans or cancel their trip. The extent to which differences in these factors between the planned California HSR service and the various European city-pair examples would cause the rail market share in California to be higher or lower than the European experience is unclear.

One concern that has been raised is that many California travelers do not have the familiarity with rail travel that most Europeans do. While this is undoubtedly true today, the experience with improvements in rail travel in the Northeast Corridor, including the introduction of the Acela service, as well as the growing ridership on existing rail services in California, suggests that U.S. travelers are willing to try new rail services if they provide advantages over driving or flying. New HSR services in the U.S. may take somewhat longer to achieve full market penetration than comparable service in Europe, but by 2035 the planned HSR system could have achieved widespread acceptance as a viable alternative to air travel.

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Regional Airport System Planning Analysis Update
Noise Technical Report

HMMH Report No 303890
July 2010

Prepared for:

SH&E
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Metropolitan Transportation Commission

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1 Introduction

Harris Miller Miller and Hanson (HMMH) conducted the airport noise Target Analysis for the Metropolitan Transportation Commission's (MTC) Regional Airport System Planning Analysis (RASPA) update. The objective of the RASPA update is to evaluate a range of solutions to Bay Area airport capacity issues while avoiding constructing new runways in the Bay. The RASPA update used 2007 as the Existing Conditions year and 2035 as the Future year. The Future analysis includes the 2035 Baseline Scenario plus six alternative scenarios which examine various potential airport capacity solutions. The analysis included all three major Bay Area airports, Oakland International Airport (OAK), San Francisco International Airport (SFO), and Norman Y. Mineta San José International Airport (SJC) as well as three regional airports, Buchanan Field Airport (CCR), Charles M. Schulz Sonoma County Airport (STS), and Travis Air Force Base (SUU).

The alternative scenarios that were analyzed for the airport noise Target Analysis are listed below¹:

Airport Redistribution

This scenario assumes a redistribution of airline service among the three major airports to take advantage of unused runway capacity at less congested airports.

Internal Regional Airports:

This scenario assumes some air passenger demand will be served at Bay Area Alternative Airports, i.e., CCR, STS, and SUU.

External Regional Airports:

This scenario assumes some air passenger demand will be served at Alternative Airports outside the region, i.e., Sacramento International Airport, Monterrey Peninsula Airport, and Stockton Airport.

High Speed Rail:

This scenario assumes construction of a new California High Speed Rail (HSR) system which diverts some air passengers to rail.

New Air Traffic Control Technologies:

This scenario assumes implementation of various new Air Traffic Control (ATC) Technologies to improve runway and airspace capacity in good and bad weather.

Demand Management:

This scenario assumes that SFO adopts Demand Management strategies to better balance aircraft demand with available runway capacity. It assumes some form of differential pricing to promote the use of larger commercial service aircraft during peak hours, bus substitution in close-in markets, and policies that encourage growth in GA demand to shift to GA reliever airports in the Bay Area region.

The noise performance measure for the Target Analysis is the residential population within the 65 decibel (dB) Community Noise Equivalent Level (CNEL) contour. The target of the noise analysis is no increase

¹ Detailed table of operations for each analysis case are presented in Appendix A

in the regional residential population exposed to 65 dB CNEL or greater in 2035 as compared to 2007. In addition, this report presents the residential population within the 55 dB CNEL contour.

2 Noise Modeling Methodology

A set of reference airport operations and the associated CNEL contour grid from a recent Integrated Noise Model (INM) study at each project airport formed the foundation of the noise analysis. Airport staff provided these files to the project team. That foundation was built upon using existing and forecast operations provided by SH&E for the RASPA Update analysis cases. In short, by comparing the operations for an analysis case to the reference operations HMMH determined if the analysis case operations produced more or less noise than the reference operations. HMMH then increased or decreased the size of the reference noise contours based on the operations comparison to produce the noise contours for the analysis case.

For an explanation of the CNEL metric and other airport noise terms see Appendix B.

2.1 Comparing Airport Operations Using the Area Equivalent Method

In order to estimate the difference in noise levels between a particular set of reference operations and the airport operations for a particular RASPA Update analysis case, HMMH applied Version 7.0 of the Federal Aviation Administration's (FAA) Area Equivalent Method (AEM)².

AEM is a spreadsheet model which estimates the percentage change in the area of the 65 dB Day-Night Average Sound Level (DNL) contour using only total daytime and nighttime aircraft operations specified by INM aircraft types for a Base and Alternative case. AEM does not take as input flight tracks, stage lengths, runway geometry, or aircraft profiles and thus does not account for changes in these parameters when comparing the different scenarios. HMMH adjusted the AEM operations input to account for the differences in time weighting between the DNL and CNEL metrics using the following formula:

$$\text{AEM Daytime Operations Input} = \text{Daytime Operations} + 3 * \text{Evening Operations}$$

The adjusted operations for the reference case and the particular RASPA Update analysis case were entered into the AEM. The AEM computed the area of the 65 dB CNEL contour for each set of operations³. The percentage difference in area was utilized in the next step, scaling the reference noise contours.

2.2 Generating Noise Contours with NMPlot

HMMH produced the final noise contours for each RASPA Update analysis case using the latest available version (v4.964) of the noise contouring program NMPlot⁴. NMPlot is the standard noise contouring

² The AEM and the AEM User's Guide are freely available from the FAA here:

http://www.faa.gov/about/office_org/headquarters_offices/aep/models/aem_model/ (Accessed September 2009).

³ Note that the contour area produced by the AEM is an estimate for a simple one-runway configuration neglecting all standard INM input excepting aircraft operations totals. It is not to be interpreted as an actual contour area for the airport in question. The purpose of the AEM is a comparison of scenarios where the only change is aircraft operations. The percentage change in area, not the area itself is the important output of the AEM.

⁴ NMPlot and the NMPlot User's Guide are freely available from Wasmer Consulting here:

<http://wasmerconsulting.com/nmplot.htm> (Accessed October 2009).

program shipped with a variety of government noise modeling including INM. It takes as input a grid of values and draws contours of equal value.

The AEM operations comparison established the estimated percentage difference in contour area between the reference data and the RASPA Update analysis case. HMMH added or subtracted values from the entire reference noise contour grid in NMPlot, to achieve the desired percentage change in the area of the 65 dB CNEL contour. The 65 dB and 55 dB CNEL contours were then exported for the population analysis.

The exception to this method was the analysis of the noise contours at STS. An INM grid file was not available for use in this study. However, an electronic file of the 65 dB CNEL noise contour line was available. Using the same AEM method as outlined above, scale factors for the area of the 65dB CNEL contour were determined for each analysis case. The reference contour was then scaled graphically in a GIS environment to produce the analysis case 65 dB CNEL contour. The 55 dB CNEL contour for each analysis case was produced in a similar manner by scaling the reference 65 dB CNEL contour.

3 Population Impact Analysis Methodology

The analysis of population within the 65dB and 55dB CNEL contours was conducted using a Geographic Information System (GIS) program. The Association of Bay Area Governments (ABAG) provided estimated residential population counts by United States Census Tract for 2007⁵ and 2035. The values were distributed from the Census Tracts enumeration units to Census Block enumeration units (see Figure 1 for a comparison of Census Tracts and Blocks). The percent of total population for each Census Block was calculated comparing the population values for the year 2000 to the total tract population for the same year. This percent value was then used to assign projected growth population to each Census Block for the required years⁶.

Using GIS tools, the contours were intersected with the Census Block data for each CNEL noise contour interval. The resultant wholly or partially encompassed Census Block areas were then calculated to determine the percent of original Census Block that was impacted. This percentage value was then used to determine the estimated residential population and housing unit counts impacted in the following manner:

$$\begin{array}{ccccc} \text{Block Population within} & = & \text{Percentage of Block Area within} & * & \text{Total Block} \\ \text{Noise Contour} & & \text{Noise Contour} & & \text{Population} \end{array}$$

The total population within the contour was summed from the results for each Census block. In this way HMMH computed the total residential population within the 65 dB and 55dB CNEL contours for each study analysis case.

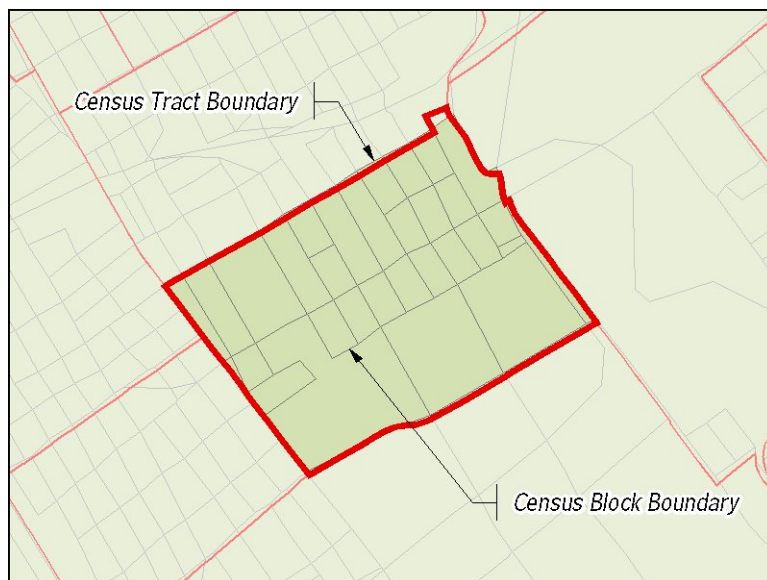


Figure 1 United States Census Tract and Blocks

⁵ Values for 2007 were linearly interpolated between the 2005 and 2010 estimates.

⁶ The 55 dB contours for SUU extended slightly beyond the borders of the ABAG population forecast. The contours intersected a single census block with non-zero residential population in the 2000 Census. The Census 2000 population for this block was utilized for all analysis cases.

It should be noted that these estimates of residences within the noise contours may differ from counts in other noise studies. Other detailed studies may use parcel-level data, land use maps, or field verification to distinguish residential portions of the Census Block from non-residential areas. This survey-level analysis relies on the assumption of an even population distribution across each Census Block. Additionally, the counts presented in this study do not distinguish between residences which are deemed as compatible due to a mitigation measure such as sound insulation and those that have not been mitigated or otherwise deemed compatible.



4 Noise Modeling Results

The presentation of population within the 65 dB and 55 dB CNEL contours is divided into three parts. The first section presents the results for each analysis scenario. The second section parses the results to separate the effects of changes in noise level and population growth. The third section attributes the differences in noise exposure between the scenarios to the trends in aircraft operations.

4.1 Results

Table 1 presents the population within the 65 dB CNEL contour for each analysis scenario. The 2007 Existing scenario results reflect noise levels in 2007 and estimated 2007 population. The increases in exposed population for the 2035 analysis scenarios reflect both the changes in noise levels due to aircraft operations and the expected growth in population between 2007 and 2035.

The High Speed Rail scenario results in the lowest population within the 65 dB CNEL contours in 2035 for both OAK and SJC and all airports combined. The lowest population count for SFO occurs for the Airport Redistribution scenario.

The Airport Redistribution scenario results in the highest population within the 65 dB CNEL contours in 2035 for both OAK and SJC. The highest population count for SFO and the three airports combined occurs for the Baseline scenario.

Table 1 Residential Population within the 65 dB CNEL Contour by Airport and Analysis Scenario

Airport	2007 Existing	2035 Baseline	2035 Airport Redistribution	2035 Internal Regional Airports	2035 External Regional Airports	2035 High Speed Rail	2035 New Air Traffic Control Technologies	2035 Demand Management
OAK	486	657	731	617	644	593	656	657
SFO	20,196	48,614	46,287	47,934	48,323	47,073	47,644	48,033
SJC	1,749	5,644	7,385	5,601	4,927	3,571	5,644	5,644
CCR	20	33	33	76	33	33	33	33
STS	143	224	224	236	224	224	224	224
SUU	786	1,008	1,008	1,010	1,008	1,008	1,008	1,008
Total	23,380	56,180	55,668	55,474	55,159	52,502	55,209	55,599

Table 2 presents the population within the 55 dB CNEL contour for each analysis scenario. The 2007 Existing scenario results reflect noise levels in 2007 and estimated 2007 population. The increases in exposed population for the 2035 analysis scenarios reflect both the changes in noise levels due to aircraft operations and the growth of population between 2007 and 2035.

The High Speed Rail scenario results in the lowest population within the 65 dB CNEL contours in 2035 for OAK and SJC as well as all airports combined. The lowest population count for SFO occurs for the Airport Redistribution scenario.

The Airport Redistribution scenario results in the highest population within the 55 dB CNEL contours in 2035 for OAK and SJC as well as all airports combined. The highest population count for SFO occurs for the Baseline scenario.

Table 2 Residential Population within the 55 dB CNEL Contour by Airport and Analysis Scenario

Airport	2007 Existing	2035 Baseline	2035 Airport Redistribution	2035 Internal Regional Airports*	2035 External Regional Airports	2035 High Speed Rail	2035 New Air Traffic Control Technologies	2035 Demand Management
OAK	35,003	48,139	52,541	45,708	47,302	44,464	48,014	48,139
SFO	127,289	193,235	187,614	191,513	192,467	189,427	190,804	191,744
SJC	53,947	145,195	152,530	144,990	141,074	130,899	145,195	145,195
CCR	2,811	3,906	3,906	6,493	3,906	3,906	3,906	3,906
STS	694	1,049	1,049	1,100	1,049	1,049	1,049	1,049
SUU	8,852	10,714	10,714	10,726	10,714	10,714	10,714	10,714
Total	228,596	402,238	408,354	400,530	396,512	380,459	399,682	400,747

4.2 Effects of Changes in Noise and Population Growth

The effect of changes in noise can be isolated from changes in population by computing the exposed population for each scenario without changing the population data. Table 3 and Table 4 present the 2007 population within the 65 dB and 55 dB CNEL contours for each analysis scenario.

The scenarios with the greatest and least exposed population for each individual airport and the three airports combined remain unchanged from those in the previous section.

Table 3 2007 Residential Population within the 65 dB CNEL Contour by Airport and Analysis Scenario

Airport	2007 Existing	2035 Baseline	2035 Airport Redistribution	2035 Internal Regional Airports*	2035 External Regional Airports	2035 High Speed Rail	2035 New Air Traffic Control Technologies	2035 Demand Management
OAK	486	617	686	578	605	557	615	617
SFO	20,196	40,385	38,408	39,807	40,132	39,077	39,567	39,887
SJC	1,749	3,019	3,880	3,001	2,668	2,003	3,019	3,019
CCR	20	28	28	62	28	28	28	28
STS	143	214	214	225	214	214	214	214
SUU	786	786	786	788	786	786	786	786
Total	23,380	45,049	44,002	44,461	44,433	42,665	44,229	44,551

Table 4 2007 Residential Population within the 55 dB CNEL Contour by Airport and Analysis Scenario

Airport	2007 Existing	2035 Baseline	2035 Airport Redistribution	2035 Internal Regional Airports*	2035 External Regional Airports	2035 High Speed Rail	2035 New Air Traffic Control Technologies	2035 Demand Management
OAK	35,003	41,823	45,555	39,729	41,109	38,636	41,723	41,823
SFO	127,289	160,329	155,672	158,923	159,718	157,188	158,351	159,120
SJC	53,947	61,422	65,003	61,328	59,648	55,579	61,422	61,422
CCR	2,811	3,393	3,393	5,679	3,393	3,393	3,393	3,393
STS	694	931	931	970	931	931	931	931
SUU	8,852	8,852	8,852	8,862	8,852	8,852	8,852	8,852
Total	228,596	276,750	279,406	275,491	273,651	264,579	274,672	275,541

Table 5 and Table 6 parse the differences between the 2007 Existing and 2035 Baseline Scenarios results in the four tables above to show the relative importance of differences in noise and population to the total difference in population within the 65 dB and 55 dB CNEL contours.

Table 5 Comparison of Noise Effects and Population Growth Effects for the 2035 Baseline Scenario – 65 dB CNEL

Airport	2007 Population within 2007 Existing Contour	2007 Population Between 2007 Existing Contour and 2035 Baseline Contour	Population Growth within 2035 Baseline Contour	Total 2035 Population within 2035 Baseline Contour	Percentage of Change Due to Noise	Percentage of Change Due to Population Growth
OAK	486	131	40	657	77%	23%
SFO	20,196	20,189	8,229	48,614	71%	29%
SJC	1,749	1,270	2,625	5,644	33%	67%
CCR	20	8	5	33	62%	38%
STS	143	71	10	224	88%	12%
SUU	786	0	222	1,008	0%	100%
Total	23,380	21,669	11,131	56,180	66%	34%

Table 6 Comparison of Noise Effects and Population Growth Effects for the 2035 Baseline Scenario – 55 dB CNEL

Airport	2007 Population within 2007 Existing Contour	2007 Population Between 2007 Existing Contour and 2035 Baseline Contour	Population Growth within 2035 Baseline Contour	Total 2035 Population within 2035 Baseline Contour	Percentage of Change Due to Noise	Percentage of Change Due to Population Growth
OAK	35,003	6,820	6,316	48,139	52%	48%
SFO	127,289	33,040	32,906	193,235	50%	50%
SJC	53,947	7,475	83,773	145,195	8%	92%
CCR	2,811	582	513	3,906	53%	47%
STS	694	237	118	1,049	67%	33%
SUU	8,852	0	1,862	10,714	0%	100%
Total	228,596	48,154	125,488	402,238	28%	72%

4.3 Noise Contributors

The analysis of noise contributors is divided into two sections. The first examines the differences in noise levels between the 2007 Existing and 2035 Baseline scenarios. The second section examines the differences in noise between the 2035 Baseline and the various 2035 alternative scenarios.

4.3.1 2035 Baseline Compared to 2007 Existing

Table 7 displays the percentage allocation of aircraft operations by time of day, the total number of actual and effective operations, the ratio of effective operations to actual operations and the change in noise level between the 2007 Existing and 2035 Baseline scenarios. The table shows that actual operations increase at all airports between 2007 and 2035. The number of effective operations is computed by adding the daytime operations to three times the evening operations and ten times the night operations. These multipliers are the same as the CNEL metric uses. On a percentage basis the effective operations increase more than the actual operations. The slight shift of operations for each airport toward the evening and nighttime can be seen in the column which displays the ratio of effective operations to actual operations. A higher number indicates a greater proportion of operations in the evening and nighttime.

The final column in the table lists the increase in CNEL between the 2007 Existing and the 2035 Baseline scenarios. As can be seen, the greatest increases in both effective operations and noise occur for SFO.

Table 7 Distribution of 2007 Existing and 2035 Baseline Operations

Airport	Scenario	Percentage Daytime Operations	Percentage Evening Operations	Percentage Nighttime Operations	Average Daily Landing and Takeoff Cycles	Average Daily Effective Operations	Effective Operations per Actual Operation	Approximate Change in CNEL Relative to 2007 Existing
OAK	2007 Existing	71.1%	13.5%	15.4%	462	1226	2.65	-
	2035 Baseline	69.5%	14.6%	15.9%	486	1324	2.72	0.8
SFO	2007 Existing	74.6%	11.8%	13.6%	511	1257	2.46	-
	2035 Baseline	73.8%	12.0%	14.2%	721	1817	2.52	2.2
SJC	2007 Existing	76.9%	16.2%	6.9%	274	533	1.95	-
	2035 Baseline	76.7%	16.2%	7.1%	333	653	1.96	0.8
CCR	2007 Existing	93.6%	4.7%	1.7%	172	215	1.25	-
	2035 Baseline	93.6%	4.7%	1.7%	183	229	1.25	0.5
STS	2007 Existing	89.7%	7.6%	2.7%	177	246	1.39	-
	2035 Baseline	90.0%	7.5%	2.5%	268	369	1.37	2.9
SUU	2007 Existing	76.6%	14.8%	8.6%	85	176	2.07	-
	2035 Baseline	76.6%	14.8%	8.6%	85	176	2.07	0.0

The AEM does not have the functionality to compute the contribution of individual aircraft to the changes in noise level. However, the INM has this capability and is the basis for the calculations in the AEM. It would be reasonable to use noise values computed from the INM to determine the most important aircraft to the changes observed in the AEM. A table of INM-computed Sound Exposure Level (SEL) values for arrivals and departures at a location close-in to a test airport was utilized to examine the noise contributors. For details on changes in operations between the noise analysis scenarios, reference the detailed operations tables in Appendix A

For OAK, the dominant factor to the increase in noise levels was an increase in airline passenger B-737s. The next largest factor was the introduction of B-777s. These increases in noise were partially offset by the elimination of operations by B-727s and the reduction in DC10/MD11 operations.

At SFO, an increase in B-747 operations was the greatest contributing factor to increases in noise levels with an increase in B-737 operations also playing a significant role. These increases were offset slightly by a small reduction in noise due to the elimination of B-757 operations.

At SJC increases in operations by A-318/319/320/321s, B-737s, and LJ35s were the top contributors to the increase in noise. The largest decrease in noise levels occurred due to the elimination of MD80s.

Growth in propeller aircraft operations at CCR was the primary cause of the increase in noise between 2007 and 2035.

The introduction of Very Light Jet (VLJ), regional jet, and B-737 operations plus the increase in other jet operations at STS were the primary causes of the increase in noise between 2007 and 2035.

At SUU the operations remained unchanged between 2007 and 2035.

4.3.2 2035 Alternative Scenarios Compared to 2035 Baseline

Table 8 displays the percentage allocation of aircraft operations by time of day, the total number of actual and effective operations, the ratio of effective operations to actual operations and the change in noise level between each 2035 analysis scenario and the 2035 Baseline scenarios.

As shown, the distribution of flights by time of day changes between the Baseline and each of the scenarios. For example, the percentage of SFO's flights in the noise sensitive evening and nighttime hours declines compared to the Baseline. The principal reason for changes in the time-of-day distribution of flight is the reduction in average aircraft delays which results in fewer flights being shifted from daytime to evening or from evening to nighttime hours. Changes to airline flight schedules in the demand management scenario, in which flights are reduced during the morning and early afternoon peak at SFO, also alters the time-of-day distribution of aircraft flights at SFO.

Table 8 Distribution of 2035 Baseline and Alternative Scenarios Operations

Airport	Scenario	Percentage Daytime Operations	Percentage Evening Operations	Percentage Nighttime Operations	Average Daily Landing and Takeoff Cycles	Average Daily Effective Operations	Effective Operations per Actual Operation	Approx. Change in CNEL Relative to 2035 Baseline
OAK	2035 Baseline	69.5%	14.6%	15.9%	486	1324	2.72	-
	2035 Airport Redistribution	69.3%	14.8%	15.9%	517	1408	2.72	0.4
	2035 Internal Regional Airports	69.6%	14.4%	15.9%	469	1276	2.72	-0.2
	2035 External Regional Airports	69.6%	14.5%	15.9%	480	1306	2.72	-0.1
	2035 High Speed Rail	69.7%	14.4%	15.9%	461	1255	2.72	-0.3
	2035 New Air Traffic Control Technologies	69.6%	14.5%	15.8%	486	1320	2.71	0.0
	2035 Demand Management	Same as 2035 Baseline						

Table 8 Distribution of 2035 Baseline and Alternative Scenarios Operations

Airport	Scenario	Percentage Daytime Operations	Percentage Evening Operations	Percentage Nighttime Operations	Average Daily Landing and Takeoff Cycles	Average Daily Effective Operations	Effective Operations per Actual Operation	Approx. Change in CNEL Relative to 2035 Baseline
SFO	2035 Baseline	73.8%	12.0%	14.2%	721	1817	2.52	-
	2035 Airport Redistribution	74.3%	11.9%	13.8%	670	1661	2.48	-0.2
	2035 Internal Regional Airports	73.9%	11.9%	14.1%	707	1773	2.51	-0.1
	2035 External Regional Airports	73.9%	11.9%	14.2%	716	1800	2.51	0.0
	2035 High Speed Rail	74.2%	11.9%	13.9%	683	1702	2.49	-0.2
	2035 New Air Traffic Control Technologies	74.6%	11.9%	13.5%	721	1770	2.45	-0.1
	2035 Demand Management	74.0%	12.0%	14.0%	692	1732	2.50	-0.1
SJC	2035 Baseline	76.7%	16.2%	7.1%	333	653	1.96	-
	2035 Airport Redistribution	76.4%	16.5%	7.1%	357	704	1.97	0.4
	2035 Internal Regional Airports	76.7%	16.2%	7.1%	332	652	1.96	0.0
	2035 External Regional Airports	76.8%	16.1%	7.1%	322	632	1.96	-0.2
	2035 High Speed Rail	77.1%	15.8%	7.1%	302	591	1.96	-0.6
	2035 New Air Traffic Control Technologies	76.7%	16.2%	7.1%	333	653	1.96	0.0
	2035 Demand Management	Same as 2035 Baseline						
CCR	2035 Baseline	93.6%	4.7%	1.7%	183	229	1.25	-
	2035 Airport Redistribution	Same as 2035 Baseline						
	2035 Internal Regional Airports	93.6%	4.7%	1.7%	213	265	1.25	1.4
	2035 External Regional Airports	Same as 2035 Baseline						
	2035 High Speed Rail	Same as 2035 Baseline						
	2035 New Air Traffic Control Technologies	Same as 2035 Baseline						
	2035 Demand Management	Same as 2035 Baseline						
STS	2035 Baseline	90.0%	7.5%	2.5%	268	369	1.37	-
	2035 Airport Redistribution	Same as 2035 Baseline						
	2035 Internal Regional Airports	90.0%	7.5%	2.5%	282	388	1.37	0.4
	2035 External Regional Airports	Same as 2035 Baseline						
	2035 High Speed Rail	Same as 2035 Baseline						
	2035 New Air Traffic Control Technologies	Same as 2035 Baseline						
	2035 Demand Management	Same as 2035 Baseline						
SUU	2035 Baseline	76.6%	14.8%	8.6%	85	176	2.07	-

Table 8 Distribution of 2035 Baseline and Alternative Scenarios Operations

Airport	Scenario	Percentage Daytime Operations	Percentage Evening Operations	Percentage Nighttime Operations	Average Daily Landing and Takeoff Cycles	Average Daily Effective Operations	Effective Operations per Actual Operation	Approx. Change in CNEL Relative to 2035 Baseline
	2035 Airport Redistribution	Same as 2035 Baseline						
	2035 Internal Regional Airports	80.0%	13.0%	7.0%	114	216	1.89	0.0
	2035 External Regional Airports	Same as 2035 Baseline						
	2035 High Speed Rail	Same as 2035 Baseline						
	2035 New Air Traffic Control Technologies	Same as 2035 Baseline						
	2035 Demand Management	Same as 2035 Baseline						

Examination of the table above and the INM SELs noise contributors analysis leads to the following observations:

- OAK 2035 Airport Redistribution – increase in noise due primarily to increase in B-737 operations
- OAK 2035 Internal Regional Airports – decrease in noise due primarily to decrease in B-737 operations
- OAK 2035 External Regional Airports - decrease in noise due primarily to decrease in B-737 operations
- OAK 2035 High Speed Rail - decrease in noise due primarily to decrease in B-737 operations
- OAK 2035 New Air Traffic Control Technologies – very slight decrease in noise due primarily to slight shift in operations toward evening and daytime periods
- SFO 2035 Airport Redistribution – decrease in noise due primarily to decrease in B-737 and A-318/319/320/321 operations
- SFO 2035 Internal Regional Airports – decrease in noise due primarily to decrease in B-737 and A-318/319/320/321 operations
- SFO 2035 External Regional Airports – decrease in noise due primarily to decrease in B-737 and A-318/319/320/321 operations
- SFO 2035 High Speed Rail – decrease in noise due primarily to decrease in B-737 and A-318/319/320/321 operations
- SFO 2035 New Air Traffic Control Technologies – decrease in noise due primarily to shift in operations toward evening and daytime periods especially for B-737, B-747, and A-318/319/320/321 operations

- SFO 2035 Demand Management –slight decrease in noise due shifts and decreases in operations by regional jets, turboprops, and general aviation aircraft
- SJC 2035 Airport Redistribution – increase in noise due primarily to increase in B-737 and A-318/319/320/321 operations
- SJC 2035 Internal Regional Airports – essentially no change in noise due to very slight decreases in B-737, A-318/319/320/321, and RJ-700 aircraft
- SJC 2035 External Regional Airports - decrease in noise due primarily to decrease in B-737 and A-318/319/320/321 operations
- SJC 2035 High Speed Rail - decrease in noise due primarily to decrease in B-737 and A-318/319/320/321 operations
- SJC 2035 New Air Traffic Control Technologies – essentially no change in noise due to shifts in operations
- CCR Internal Regional Airports – increase in noise due to addition of service by CRJ-700.
- STS Internal Regional Airports – increase in noise due to increase operations by CRJ-700.
- SUU Internal Regional Airports –addition CRJ-700 operations has negligible effect due to high noise levels from military aircraft.

Appendix A Aircraft Operations Tables

The AEM requires average daily operations by aircraft type in terms of landing and takeoff cycles (LTOs) in order to estimate the area of a specified noise contour. SH&E produced the required tables of operations for each analysis scenario in the RASPA Update.

In order to enter these operations into the AEM, HMMH matched each aircraft in the SH&E tables to a specific type within the AEM. In many cases a simple one-to-one match was possible. When multiple types matched (e.g. a Boeing 737-300 can be a 737300 or 7373B3 in the AEM depending on the particular engines), HMMH distributed the operations among the AEM types using percentages developed from a database of all commercial aircraft operating in the United States. The AEM has a limited number of military aircraft types and no helicopters. Single engine helicopters were modeled as a single engine propeller aircraft and twin engine helicopters were modeled as a twin engine propeller aircraft. For cases where a fixed-wing type was not available in the AEM, the noise values for the desired aircraft were compared to the available AEM aircraft using the INM. The closest match was used as the proxy in the AEM.

Table 9 displays the AEM type(s) used for each aircraft in the SH&E operations tables. For traceability the aircraft types are exactly as received from SH&E. The remaining tables in this appendix display the operations used for each analysis case.

Table 9 AEM Aircraft Type Assignments

Aircraft	AEM Type	Fraction (0.01 = 1%)
747	747200	0.05
747	747400	0.38
747	74710Q	0.09
747	74720A	0.09
747	74720B	0.34
747	747SP	0.03
757	757300	0.06
757	757PW	0.51
757	757RR	0.43
767	767300	0.66
767	767400	0.10
767	767CF6	0.21
767	767JT9	0.03
777	777200	1.00
727 (all)	727D17	0.01
727 (all)	727EM1	0.09
727 (all)	727EM2	0.73
727 (all)	727Q15	0.01
727 (all)	727Q7	0.02
727 (all)	727Q9	0.04
727 (all)	727QF	0.11
737-200/300	737300	0.61
737-200/300	7373B2	0.24
737-200/300	737N17	0.09
737-200/300	737N9	0.06
737-3/4/500	737300	0.46
737-3/4/500	737400	0.16
737-3/4/500	737500	0.20
737-3/4/500	7373B2	0.18
737-3/500	737300	0.55
737-3/500	737500	0.24
737-3/500	7373B2	0.22
737-300	737300	0.72
737-300	7373B2	0.28
737-400/500	737400	0.44
737-400/500	737500	0.56
737-7/8/900	737700	0.55
737-7/8/900	737800	0.45
737-7/900	737700	0.93
737-7/900	737800	0.07
737-700/800/900	737700	0.55
737-700/800/900	737800	0.45
747 (all)	747200	0.05
747 (all)	747400	0.38
747 (all)	74710Q	0.09
747 (all)	74720A	0.09
747 (all)	74720B	0.34

Table 9 AEM Aircraft Type Assignments

Aircraft	AEM Type	Fraction (0.01 = 1%)
747 (all)	747SP	0.03
757 (all)	757300	0.06
757 (all)	757PW	0.51
757 (all)	757RR	0.43
767 (all)	767300	0.66
767 (all)	767400	0.10
767 (all)	767CF6	0.21
767 (all)	767JT9	0.03
777 (all)	777200	1.00
787-9 / A-350	A330-343	1.00
A109	BEC58P	1.00
A109 - Helicopter	BEC58P	1.00
A300	A300-622R	0.87
A300	A300B4-203	0.13
A-318/319/320/321	A319-131	0.43
A-318/319/320/321	A320-211	0.16
A-318/319/320/321	A320-232	0.36
A-318/319/320/321	A321-232	0.05
A330	A330-301	1.00
A-330/340	A330-301	0.50
A-330/340	A340-211	0.50
A-380	747400	1.00
AC90	CNA441	1.00
ASTR	IA1125	1.00
AT43	DHC8	1.00
AT43/AT72/BA41	DHC8	0.32
AT43/AT72/BA41	HS748A	0.59
AT43/AT72/BA41	SF340	0.09
AT72	HS748A	1.00
B190/BE99/PA32	1900D	0.57
B190/BE99/PA32	DHC6	0.25
B190/BE99/PA32	GASEPV	0.18
B206L	GASEPV	1.00
B350	DHC6	1.00
BE20	DHC6	1.00
BE30	DHC6	1.00
BE35	GASEPV	1.00
BE36	GASEPV	1.00
BE40	MU3001	1.00
BE55	BEC58P	1.00
BE58	BEC58P	1.00
BE60	BEC58P	1.00
BE76	BEC58P	1.00
BE95	BEC58P	1.00
BE99	DHC6	1.00
BE9L	CNA441	1.00
BEC190	1900D	1.00

Table 9 AEM Aircraft Type Assignments

Aircraft	AEM Type	Fraction (0.01 = 1%)
BEC58P	BEC58P	1.00
BEC9F	CNA441	1.00
Beech 400	MU3001	1.00
Boeing 737-700	737700	1.00
C130	C130	1.00
C-141A	707320	1.00
C150	CNA172	1.00
C152	CNA172	1.00
C172	CNA172	1.00
C182	CNA206	1.00
C206	CNA206	0.82
C206	CNA20T	0.18
C208	GASEPF	1.00
C210	CNA206	0.59
C210	CNA20T	0.41
C25A	CNA500	1.00
C25B	CNA500	1.00
C310	BEC58P	1.00
C340	BEC58P	1.00
C402	BEC58P	1.00
C414	BEC58P	1.00
C421	BEC58P	1.00
C425	CNA441	1.00
C441	CNA441	1.00
C501	CNA500	1.00
C525	CNA500	1.00
C550	CNA55B	0.14
C550	MU3001	0.86
C560	MU3001	1.00
C56X	CNA55B	1.00
C-5A	74720B	1.00
C650	CIT3	1.00
C680	LEAR35	1.00
C750	CNA750	1.00
Cessna 550	MU3001	1.00
Cessna 650	CIT3	1.00
Cessna 750	CNA750	1.00
Challenger 600	CL600	1.00
CIT3	CIT3	1.00
CL30	CL600	1.00
CL60	CL600	0.03
CL60	CL601	0.97
CL600	CL600	1.00
CNA172	CNA172	1.00
CNA206	CNA206	1.00
CNA20T	CNA20T	1.00
CNA441	CNA441	1.00

Table 9 AEM Aircraft Type Assignments

Aircraft	AEM Type	Fraction (0.01 = 1%)
CNA500	CNA500	1.00
CNA55B	CNA55B	1.00
CNA750	CNA750	1.00
CRJ-700	GV	1.00
CRJ-700-RJ	GV	1.00
CRJ-900-RJ	GV	1.00
D328	DHC8	1.00
DC10/MD11	DC1010	0.28
DC10/MD11	DC1030	0.25
DC10/MD11	MD11GE	0.21
DC10/MD11	MD11PW	0.25
DC8	DC870	0.71
DC8	FAL20	0.29
DC9	DC93LW	0.72
DC9	DC95HW	0.28
DH8D	DHC830	1.00
DHC6	DHC6	1.00
DHC8	DHC8	1.00
DHC-8-100	DHC8	1.00
DHC830	DHC830	1.00
DHC-8-400	DHC830	1.00
EMB-120	EMB120	1.00
EMB-140	EMB145	1.00
EMB-145/ERJ-145	EMB145	0.08
EMB-145/ERJ-145	EMB14L	0.92
EMB-170	GV	1.00
EMB-170-RJ	GV	1.00
EMB-190	EMB14L	1.00
EMB-190-RJ	GV	1.00
F16	F16A	1.00
F18	A7D	1.00
F2TH	CL600	1.00
F900	LEAR35	1.00
FA20	FAL20	0.92
FA20	LEAR35	0.08
FA50	LEAR35	1.00
FAL20	FAL20	1.00
Falcon 50	LEAR35	1.00
Falcon 900	LEAR35	1.00
G159	HS748A	1.00
GALX	CL601	1.00
GASEPF	GASEPF	1.00
GASEPV	GASEPV	1.00
GIIB	GIIB	1.00
GIV	GIV	1.00
GL5T	GV	1.00
GLEX	GV	1.00

Table 9 AEM Aircraft Type Assignments

Aircraft	AEM Type	Fraction (0.01 = 1%)
GLF2	GII	0.90
GLF2	GIIB	0.10
GLF3	GIIB	1.00
GLF4	GIV	1.00
GLF5	GV	1.00
Gulfstream III	GIIB	1.00
Gulfstream IV	GIV	1.00
Gulfstream V	GV	1.00
H25A	LEAR25	0.20
H25A	LEAR35	0.80
H25B	LEAR35	1.00
Hawker H25	LEAR35	1.00
HS748A	HS748A	1.00
IA1125	IA1125	1.00
KC-10A	DC950	1.00
KC-135R	KC135	1.00
Lear 45	LEAR35	1.00
Lear 60	LEAR35	1.00
LEAR25	LEAR25	1.00
LEAR35	LEAR35	1.00
Lear60	LEAR35	1.00
LJ31	LEAR35	1.00
LJ35	LEAR35	1.00
LJ35/LR35	LEAR35	1.00
LJ45	LEAR35	1.00
LJ55	LEAR35	1.00
LJ60	LEAR35	1.00
M20P	GASEPV	1.00
MD-80 (all)	MD81	0.02
MD-80 (all)	MD82	0.49
MD-80 (all)	MD83	0.49
MU3001	MU3001	1.00
P180	SD330	1.00
P28A	GASEPF	1.00
P32R/NAV	GASEPV	1.00
P46T	SD330	1.00
PA18	GASEPF	1.00
PA31	CNA441	0.00
PA31	PA31	1.00
PA31/SW3	CNA441	0.03
PA31/SW3	PA31	0.97
PA32	GASEPV	1.00
PA34	BEC58P	1.00
PAY2	CNA441	1.00
PC12	1900D	1.00
PiaggioTwin-engine prop	DHC6	1.00
Piaggio-Twin-engine prop	DHC6	1.00

Table 9 AEM Aircraft Type Assignments

Aircraft	AEM Type	Fraction (0.01 = 1%)
PRM1	CNA500	1.00
Q-400–Twin-engine prop	DHC830	1.00
RJ-200/ER	CL601	1.00
RJ-700	GV	1.00
RJ-900	GV	1.00
SABR80	SABR80	1.00
SBR1	LEAR25	0.73
SBR1	LEAR35	0.27
SF-340	SF340	1.00
Single-engine, Fixed	GASEPF	1.00
Single-engine, Variable	GASEPV	1.00
SR22	GASEPV	1.00
SW3	CNA441	1.00
SW4	DHC6	1.00
T33	LEAR35	1.00
T-38A	LEAR25	1.00
TBM7	1900D	1.00
Twin-engine, Piston	BEC58P	1.00
Twin-engine, Turboprop	CNA441	1.00
Very Light jets (VLJ)	CNA55B	1.00
WW24	IA1125	1.00

Table 10 OAK 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-300	45.5	11.4	8.5
Airline-Psgr	737-400/500	6.2	1.5	1.1
Airline-Psgr	737-700/800/900	62.7	15.7	11.7
Airline-Psgr	757 (all)	1.7	0.4	0.3
Airline-Psgr	A-318/319/320/321	15.9	4.0	3.0
Airline-Psgr	EMB-145/ERJ-145	1.5	0.4	0.3
Airline-Psgr	MD-80 (all)	5.4	1.4	1.0
Airline-Psgr	RJ-200/ER	6.1	1.5	1.1
Airline-Psgr	RJ-700	2.0	0.5	0.4
Airline-Psgr	RJ-900	1.5	0.4	0.3
Airline-AC	747 (all)	0.1	0.0	0.1
Airline-AC	DC10/MD11	5.0	2.2	5.2
Airline-AC	A300	2.9	1.3	3.0
Airline-AC	767 (all)	1.5	0.7	1.6
Airline-AC	757 (all)	0.5	0.2	0.5
Airline-AC	DC8	0.0	0.0	0.0
Airline-AC	DC9	0.0	0.0	0.0
Airline-AC	727 (all)	1.5	0.7	1.6
Airline-AC	737-200/300	0.0	0.0	0.0
Airline-AC	LJ35/LR35	0.0	0.0	0.0
Airline-AC	AT43/AT72/BA41	0.5	0.2	0.5
Airline-AC	B190/BE99/PA32	1.4	0.6	1.4
Airline-AC	SW4	1.4	0.6	1.4
Airline-AC	PA31/SW3	2.9	1.3	3.0
Airline-AC	P32R/NAV	0.0	0.0	0.0
Airline-AC	UNK	0.0	0.0	0.0
GA-BJ	ASTR	0.2	0.0	0.0
GA-BJ	BE40	1.3	0.2	0.1
GA-BJ	C25A	0.2	0.0	0.0
GA-BJ	C25B	0.2	0.0	0.0
GA-BJ	C501	0.2	0.0	0.0
GA-BJ	C525	0.6	0.1	0.1
GA-BJ	C550	1.1	0.1	0.1
GA-BJ	C560	1.7	0.2	0.2
GA-BJ	C56X	1.1	0.1	0.1
GA-BJ	C650	0.3	0.0	0.0
GA-BJ	C680	0.3	0.0	0.0
GA-BJ	C750	1.0	0.1	0.1
GA-BJ	CL30	0.5	0.1	0.1
GA-BJ	CL60	1.5	0.2	0.2
GA-BJ	F2TH	0.6	0.1	0.1
GA-BJ	F900	0.9	0.1	0.1
GA-BJ	FA20	0.3	0.0	0.0
GA-BJ	FA50	0.6	0.1	0.1
GA-BJ	GALX	0.3	0.0	0.0
GA-BJ	GLEX	0.3	0.0	0.0
GA-BJ	GLF2	0.2	0.0	0.0

Table 10 OAK 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-BJ	GLF3	0.7	0.1	0.1
GA-BJ	GLF4	1.6	0.2	0.2
GA-BJ	GLF5	0.4	0.1	0.0
GA-BJ	H25B	1.8	0.2	0.2
GA-BJ	LJ31	0.2	0.0	0.0
GA-BJ	LJ35	1.0	0.1	0.1
GA-BJ	LJ45	0.7	0.1	0.1
GA-BJ	LJ60	0.5	0.1	0.0
GA-BJ	PRM1	0.3	0.0	0.0
GA-BJ	VW24	0.3	0.0	0.0
GA-MEL	BE55	0.3	0.0	0.0
GA-MEL	BE58	0.3	0.0	0.0
GA-MEL	BE76	0.3	0.0	0.0
GA-MEL	C206	1.0	0.1	0.2
GA-MEL	C310	0.3	0.0	0.0
GA-MEL	C340	0.5	0.0	0.1
GA-MEL	C414	0.4	0.0	0.1
GA-MEL	C421	0.4	0.0	0.1
GA-MEL	PA31	7.4	0.8	1.2
GA-SEL	BE35	1.3	0.1	0.2
GA-SEL	BE36	1.2	0.1	0.2
GA-SEL	C152	0.6	0.1	0.1
GA-SEL	C172	9.4	1.0	1.5
GA-SEL	C182	1.6	0.2	0.3
GA-SEL	C210	1.1	0.1	0.2
GA-SEL	M20P	1.6	0.2	0.3
GA-SEL	P28A	5.1	0.5	0.8
GA-SEL	SR22	1.3	0.1	0.2
GA-TP	AT43	0.6	0.1	0.1
GA-TP	AT72	0.5	0.0	0.1
GA-TP	B350	0.5	0.1	0.1
GA-TP	BE20	1.1	0.1	0.2
GA-TP	BE30	0.4	0.0	0.1
GA-TP	BE99	3.2	0.3	0.5
GA-TP	BE9L	0.5	0.1	0.1
GA-TP	C208	5.5	0.6	0.9
GA-TP	D328	0.8	0.1	0.1
GA-TP	DH8D	0.3	0.0	0.1
GA-TP	P180	0.9	0.1	0.1
GA-TP	PC12	1.5	0.2	0.2
GA-TP	SW3	0.4	0.0	0.1
GA-TP	SW4	2.8	0.3	0.4
Military	C130	0.2	0.0	0.0
Military	F18	0.2	0.0	0.0
Military	F16	0.1	0.0	0.0
Local	C152	32.5	3.4	5.2
Local	C172	26.4	2.8	4.2

Table 10 OAK 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Local	PA18	29.1	3.1	4.7
Total		328.5	62.6	71.0

Table 11 OAK 2035 Baseline Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	162.1	40.7	30.9
Airline-Psgr	787-9 / A-350	2.7	0.7	0.5
Airline-Psgr	A-318/319/320/321	27.8	7.0	5.3
Airline-Psgr	RJ-700	11.8	3.0	2.2
Airline-AC	747	0.1	0.0	0.1
Airline-AC	777	4.7	2.0	5.0
Airline-AC	A330	2.7	1.2	2.9
Airline-AC	DC10/MD11	1.6	0.7	1.7
Airline-AC	A300	0.9	0.4	1.0
Airline-AC	767	1.9	0.8	2.1
Airline-AC	757	0.6	0.3	0.6
Airline-AC	737-3/500	1.0	0.4	1.0
Airline-AC	737-7/900	1.0	0.4	1.0
Airline-AC	AT43/AT72/BA41	1.9	0.9	2.0
Airline-AC	B190/BE99/PA32	4.5	2.1	4.7
Airline-AC	SW4	0.4	0.2	0.5
Airline-AC	PA31/SW3	0.9	0.4	0.9
GA-BJ	C550	10.4	1.4	1.2
GA-BJ	C560	1.9	0.3	0.2
GA-BJ	C750	1.4	0.2	0.2
GA-BJ	CL60	2.8	0.4	0.3
GA-BJ	FA20	1.9	0.3	0.2
GA-BJ	FA50	1.4	0.2	0.2
GA-BJ	GLF4	5.2	0.7	0.6
GA-BJ	H25A	2.4	0.3	0.3
GA-BJ	H25B	3.3	0.4	0.4
GA-BJ	LJ35	3.8	0.5	0.4
GA-BJ	LJ60	0.9	0.1	0.1
GA-BJ	WW24	0.9	0.1	0.1
GA-MEL	BE58	3.1	0.3	0.5
GA-MEL	C310	0.4	0.0	0.1
GA-MEL	C402	0.8	0.1	0.1
GA-MEL	PA31	0.6	0.1	0.1
GA-SEL	C172	11.0	1.2	1.8
GA-SEL	PA32	9.0	1.0	1.5
GA-TP	BE99	6.0	0.7	1.0
GA-TP	G159	7.1	0.8	1.2
GA-TP	P46T	1.2	0.1	0.2
GA-TP	TBM7	2.4	0.3	0.4
Military	C130	0.2	0.0	0.0
Military	F18	0.2	0.0	0.0
Military	F16	0.1	0.0	0.0
Local	C152	19.7	2.2	3.2
Local	C172	16.0	1.8	2.6
Local	PA18	17.6	1.9	2.9
Total		358.41	76.54	82.02

Note: The OAK Demand Management scenario has the same operations as the 2035 Baseline scenario.

Table 12 OAK 2035 Redistribution Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	162.1	40.7	30.9
Airline-Psgr	787-9 / A-350	2.7	0.7	0.5
Airline-Psgr	A-318/319/320/321	27.8	7.0	5.3
Airline-Psgr	RJ-700	11.8	3.0	2.2
Airline-AC	747	0.1	0.0	0.1
Airline-AC	777	4.7	2.0	5.0
Airline-AC	A330	2.7	1.2	2.9
Airline-AC	DC10/MD11	1.6	0.7	1.7
Airline-AC	A300	0.9	0.4	1.0
Airline-AC	767	1.9	0.8	2.1
Airline-AC	757	0.6	0.3	0.6
Airline-AC	737-3/500	1.0	0.4	1.0
Airline-AC	737-7/900	1.0	0.4	1.0
Airline-AC	AT43/AT72/BA41	1.9	0.9	2.0
Airline-AC	B190/BE99/PA32	4.5	2.1	4.7
Airline-AC	SW4	0.4	0.2	0.5
Airline-AC	PA31/SW3	0.9	0.4	0.9
GA-BJ	C550	10.4	1.4	1.2
GA-BJ	C560	1.9	0.3	0.2
GA-BJ	C750	1.4	0.2	0.2
GA-BJ	CL60	2.8	0.4	0.3
GA-BJ	FA20	1.9	0.3	0.2
GA-BJ	FA50	1.4	0.2	0.2
GA-BJ	GLF4	5.2	0.7	0.6
GA-BJ	H25A	2.4	0.3	0.3
GA-BJ	H25B	3.3	0.4	0.4
GA-BJ	LJ35	3.8	0.5	0.4
GA-BJ	LJ60	0.9	0.1	0.1
GA-BJ	WW24	0.9	0.1	0.1
GA-MEL	BE58	3.1	0.3	0.5
GA-MEL	C310	0.4	0.0	0.1
GA-MEL	C402	0.8	0.1	0.1
GA-MEL	PA31	0.6	0.1	0.1
GA-SEL	C172	11.0	1.2	1.8
GA-SEL	PA32	9.0	1.0	1.5
GA-TP	BE99	6.0	0.7	1.0
GA-TP	G159	7.1	0.8	1.2
GA-TP	P46T	1.2	0.1	0.2
GA-TP	TBM7	2.4	0.3	0.4
Military	C130	0.2	0.0	0.0
Military	F18	0.2	0.0	0.0
Military	F16	0.1	0.0	0.0
Local	C152	19.7	2.2	3.2
Local	C172	16.0	1.8	2.6
Local	PA18	17.6	1.9	2.9
Total		358.41	76.54	82.02

Table 13 OAK 2035 Internal Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	135.8	33.9	25.3
Airline-Psgr	787-9 / A-350	2.2	0.6	0.4
Airline-Psgr	A-318/319/320/321	23.6	5.9	4.4
Airline-Psgr	RJ-700	9.8	2.5	1.8
Airline-AC	747	0.1	0.0	0.1
Airline-AC	777	4.7	2.1	5.0
Airline-AC	A330	2.7	1.2	2.9
Airline-AC	DC10/MD11	1.6	0.7	1.7
Airline-AC	A300	0.9	0.4	1.0
Airline-AC	767	1.9	0.8	2.0
Airline-AC	757	0.6	0.3	0.6
Airline-AC	737-3/500	1.0	0.4	1.0
Airline-AC	737-7/900	1.0	0.4	1.0
Airline-AC	AT43/AT72/BA41	1.9	0.9	2.0
Airline-AC	B190/BE99/PA32	4.5	2.0	4.7
Airline-AC	SW4	0.4	0.2	0.5
Airline-AC	PA31/SW3	0.9	0.4	0.9
GA-BJ	C550	10.5	1.4	1.1
GA-BJ	C560	1.9	0.3	0.2
GA-BJ	C750	1.4	0.2	0.2
GA-BJ	CL60	2.9	0.4	0.3
GA-BJ	FA20	1.9	0.3	0.2
GA-BJ	FA50	1.4	0.2	0.2
GA-BJ	GLF4	5.2	0.7	0.6
GA-BJ	H25A	2.4	0.3	0.3
GA-BJ	H25B	3.3	0.4	0.4
GA-BJ	LJ35	3.8	0.5	0.4
GA-BJ	LJ60	1.0	0.1	0.1
GA-BJ	WW24	1.0	0.1	0.1
GA-MEL	BE58	3.1	0.3	0.5
GA-MEL	C310	0.4	0.0	0.1
GA-MEL	C402	0.8	0.1	0.1
GA-MEL	PA31	0.6	0.1	0.1
GA-SEL	C172	11.1	1.2	1.8
GA-SEL	PA32	9.0	1.0	1.4
GA-TP	BE99	6.0	0.6	1.0
GA-TP	G159	7.2	0.8	1.2
GA-TP	P46T	1.2	0.1	0.2
GA-TP	TBM7	2.4	0.3	0.4
Military	C130	0.2	0.0	0.0
Military	F18	0.2	0.0	0.0
Military	F16	0.1	0.0	0.0
Local	C152	19.8	2.1	3.2
Local	C172	16.1	1.7	2.6
Local	PA18	17.7	1.9	2.8
Total		326.3	67.7	74.6

Table 14 OAK 2035 External Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	142.2	35.6	26.6
Airline-Psgr	787-9 / A-350	2.3	0.6	0.4
Airline-Psgr	A-318/319/320/321	24.7	6.2	4.6
Airline-Psgr	RJ-700	10.3	2.6	1.9
Airline-AC	747	0.1	0.0	0.1
Airline-AC	777	4.7	2.1	5.0
Airline-AC	A330	2.7	1.2	2.9
Airline-AC	DC10/MD11	1.6	0.7	1.7
Airline-AC	A300	0.9	0.4	1.0
Airline-AC	767	1.9	0.8	2.0
Airline-AC	757	0.6	0.3	0.6
Airline-AC	737-3/500	1.0	0.4	1.0
Airline-AC	737-7/900	1.0	0.4	1.0
Airline-AC	AT43/AT72/BA41	1.9	0.9	2.0
Airline-AC	B190/BE99/PA32	4.5	2.0	4.7
Airline-AC	SW4	0.4	0.2	0.5
Airline-AC	PA31/SW3	0.9	0.4	0.9
GA-BJ	C550	10.5	1.4	1.1
GA-BJ	C560	1.9	0.3	0.2
GA-BJ	C750	1.4	0.2	0.2
GA-BJ	CL60	2.9	0.4	0.3
GA-BJ	FA20	1.9	0.3	0.2
GA-BJ	FA50	1.4	0.2	0.2
GA-BJ	GLF4	5.2	0.7	0.6
GA-BJ	H25A	2.4	0.3	0.3
GA-BJ	H25B	3.3	0.4	0.4
GA-BJ	LJ35	3.8	0.5	0.4
GA-BJ	LJ60	1.0	0.1	0.1
GA-BJ	WW24	1.0	0.1	0.1
GA-MEL	BE58	3.1	0.3	0.5
GA-MEL	C310	0.4	0.0	0.1
GA-MEL	C402	0.8	0.1	0.1
GA-MEL	PA31	0.6	0.1	0.1
GA-SEL	C172	11.1	1.2	1.8
GA-SEL	PA32	9.0	1.0	1.4
GA-TP	BE99	6.0	0.6	1.0
GA-TP	G159	7.2	0.8	1.2
GA-TP	P46T	1.2	0.1	0.2
GA-TP	TBM7	2.4	0.3	0.4
Military	C130	0.2	0.0	0.0
Military	F18	0.2	0.0	0.0
Military	F16	0.1	0.0	0.0
Local	C152	19.8	2.1	3.2
Local	C172	16.1	1.7	2.6
Local	PA18	17.7	1.9	2.9
Total		334.3	69.8	76.3

Table 15 OAK 2035 Air Traffic Control Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	145.6	36.4	27.1
Airline-Psgr	787-9 / A-350	2.4	0.6	0.4
Airline-Psgr	A-318/319/320/321	25.2	6.3	4.7
Airline-Psgr	RJ-700	10.5	2.6	2.0
Airline-AC	747	0.1	0.0	0.1
Airline-AC	777	4.7	2.1	5.0
Airline-AC	A330	2.7	1.2	2.9
Airline-AC	DC10/MD11	1.6	0.7	1.7
Airline-AC	A300	0.9	0.4	1.0
Airline-AC	767	1.9	0.8	2.0
Airline-AC	757	0.6	0.3	0.6
Airline-AC	737-3/500	1.0	0.4	1.0
Airline-AC	737-7/900	1.0	0.4	1.0
Airline-AC	AT43/AT72/BA41	1.9	0.9	2.0
Airline-AC	B190/BE99/PA32	4.5	2.0	4.7
Airline-AC	SW4	0.4	0.2	0.5
Airline-AC	PA31/SW3	0.9	0.4	0.9
GA-BJ	C550	10.5	1.4	1.1
GA-BJ	C560	1.9	0.3	0.2
GA-BJ	C750	1.4	0.2	0.2
GA-BJ	CL60	2.9	0.4	0.3
GA-BJ	FA20	1.9	0.3	0.2
GA-BJ	FA50	1.4	0.2	0.2
GA-BJ	GLF4	5.2	0.7	0.6
GA-BJ	H25A	2.4	0.3	0.3
GA-BJ	H25B	3.3	0.4	0.4
GA-BJ	LJ35	3.8	0.5	0.4
GA-BJ	LJ60	1.0	0.1	0.1
GA-BJ	WW24	1.0	0.1	0.1
GA-MEL	BE58	3.1	0.3	0.5
GA-MEL	C310	0.4	0.0	0.1
GA-MEL	C402	0.8	0.1	0.1
GA-MEL	PA31	0.6	0.1	0.1
GA-SEL	C172	11.1	1.2	1.8
GA-SEL	PA32	9.0	1.0	1.4
GA-TP	BE99	6.0	0.6	1.0
GA-TP	G159	7.2	0.8	1.2
GA-TP	P46T	1.2	0.1	0.2
GA-TP	TBM7	2.4	0.3	0.4
Military	C130	0.2	0.0	0.0
Military	F18	0.2	0.0	0.0
Military	F16	0.1	0.0	0.0
Local	C152	19.8	2.1	3.2
Local	C172	16.1	1.7	2.6
Local	PA18	17.7	1.9	2.8
Total		338.6	70.7	76.9

Table 16 OAK 2035 High Speed Rail Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	129.8	32.4	24.1
Airline-Psgr	787-9 / A-350	2.4	0.6	0.4
Airline-Psgr	A-318/319/320/321	23.4	5.9	4.4
Airline-Psgr	RJ-700	10.5	2.6	2.0
Airline-AC	747	0.1	0.0	0.1
Airline-AC	777	4.7	2.1	5.0
Airline-AC	A330	2.7	1.2	2.9
Airline-AC	DC10/MD11	1.6	0.7	1.7
Airline-AC	A300	0.9	0.4	1.0
Airline-AC	767	1.9	0.8	2.0
Airline-AC	757	0.6	0.3	0.6
Airline-AC	737-3/500	1.0	0.4	1.0
Airline-AC	737-7/900	1.0	0.4	1.0
Airline-AC	AT43/AT72/BA41	1.9	0.9	2.0
Airline-AC	B190/BE99/PA32	4.5	2.0	4.7
Airline-AC	SW4	0.4	0.2	0.4
Airline-AC	PA31/SW3	0.9	0.4	0.9
GA-BJ	C550	10.5	1.4	1.1
GA-BJ	C560	1.9	0.3	0.2
GA-BJ	C750	1.4	0.2	0.2
GA-BJ	CL60	2.9	0.4	0.3
GA-BJ	FA20	1.9	0.3	0.2
GA-BJ	FA50	1.4	0.2	0.2
GA-BJ	GLF4	5.2	0.7	0.6
GA-BJ	H25A	2.4	0.3	0.3
GA-BJ	H25B	3.3	0.4	0.4
GA-BJ	LJ35	3.8	0.5	0.4
GA-BJ	LJ60	1.0	0.1	0.1
GA-BJ	WW24	1.0	0.1	0.1
GA-MEL	BE58	3.1	0.3	0.5
GA-MEL	C310	0.4	0.0	0.1
GA-MEL	C402	0.8	0.1	0.1
GA-MEL	PA31	0.6	0.1	0.1
GA-SEL	C172	11.1	1.2	1.8
GA-SEL	PA32	9.0	1.0	1.4
GA-TP	BE99	6.0	0.6	1.0
GA-TP	G159	7.2	0.8	1.2
GA-TP	P46T	1.2	0.1	0.2
GA-TP	TBM7	2.4	0.3	0.4
Military	C130	0.2	0.0	0.0
Military	F18	0.2	0.0	0.0
Military	F16	0.1	0.0	0.0
Local	C152	19.8	2.1	3.2
Local	C172	16.1	1.7	2.6
Local	PA18	17.7	1.9	2.8
Total		321.1	66.3	73.5

Table 17 SFO 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr-Dom	A-318/319/320/321	71.4	11.8	13.3
Airline-Psgr-Dom	EMB-120	49.8	8.2	9.5
Airline-Psgr-Dom	757 (all)	43.4	7.2	8.1
Airline-Psgr-Dom	RJ-200/ER	24.6	4.1	4.6
Airline-Psgr-Dom	737-700/800/900	24.2	4.0	4.5
Airline-Psgr-Dom	767 (all)	17.7	2.9	3.3
Airline-Psgr-Dom	737-300	17.0	2.8	3.2
Airline-Psgr-Dom	MD-80 (all)	15.4	2.6	2.9
Airline-Psgr-Dom	737-400/500	14.7	2.4	2.7
Airline-Psgr-Dom	RJ-700	13.2	2.2	2.5
Airline-Psgr-Dom	777 (all)	4.4	0.7	0.8
Airline-Psgr-Dom	EMB-140	3.4	0.6	0.6
Airline-Psgr-Dom	EMB-145/ERJ-145	2.4	0.4	0.4
Airline-Psgr-Dom	EMB-190	1.4	0.2	0.3
Airline-Psgr-Dom	EMB-170	0.5	0.1	0.1
Airline-Psgr-Dom	RJ-900	0.4	0.1	0.1
Airline-Psgr-Intl	747 (all)	17.4	2.5	0.8
Airline-Psgr-Intl	777 (all)	9.2	1.3	0.4
Airline-Psgr-Intl	A-330/340	3.7	0.5	0.2
Airline-AC	747 (all)	3.3	0.9	4.0
Airline-AC	777 (all)	0.0	0.0	0.0
Airline-AC	DC10/MD11	1.2	0.3	1.4
Airline-AC	A300	0.1	0.0	0.1
Airline-AC	767 (all)	0.5	0.1	0.6
Airline-AC	757 (all)	0.0	0.0	0.0
Airline-AC	DC8	0.0	0.0	0.0
Airline-AC	DC9	0.3	0.1	0.3
Airline-AC	737-200/300	0.0	0.0	0.0
GA-BJ	C750	3.7	0.4	0.3
GA-BJ	C56X	3.0	0.3	0.3
GA-BJ	GLF4	2.8	0.3	0.2
GA-BJ	H25B	2.5	0.2	0.2
GA-BJ	C560	2.4	0.2	0.2
GA-BJ	BE40	2.1	0.2	0.2
GA-BJ	CL60	2.0	0.2	0.2
GA-BJ	F2TH	1.5	0.1	0.1
GA-BJ	GALX	1.3	0.1	0.1
GA-BJ	F900	1.1	0.1	0.1
GA-BJ	CL30	1.1	0.1	0.1
GA-BJ	GLF5	1.0	0.1	0.1
GA-BJ	C550	0.9	0.1	0.1
GA-BJ	LJ60	0.8	0.1	0.1
GA-BJ	C680	0.8	0.1	0.1
GA-BJ	LJ35	0.7	0.1	0.1
GA-BJ	FA50	0.7	0.1	0.1
GA-BJ	GLF3	0.6	0.1	0.1
GA-BJ	LJ45	0.6	0.1	0.1

Table 17 SFO 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-BJ	GLEX	0.5	0.0	0.0
GA-BJ	PRM1	0.4	0.0	0.0
GA-BJ	LJ55	0.4	0.0	0.0
GA-BJ	C525	0.4	0.0	0.0
GA-BJ	C25B	0.4	0.0	0.0
GA-BJ	C650	0.3	0.0	0.0
GA-BJ	GLF2	0.2	0.0	0.0
GA-MEL	C421	2.9	0.4	0.6
GA-SEL	C182	0.2	0.0	0.0
GA-SEL	C150	0.1	0.0	0.0
GA-SEL	C172	0.1	0.0	0.0
GA-SEL	BE36	0.1	0.0	0.0
GA-TP	BE20	1.1	0.2	0.2
GA-TP	B350	0.6	0.1	0.1
GA-TP	P180	0.5	0.1	0.1
GA-TP	PAY2	0.4	0.1	0.1
GA-TP	BE30	0.3	0.0	0.1
GA-TP	BE9L	0.3	0.0	0.1
Military	C130	1.4	0.2	0.3
Military	F18	1.3	0.2	0.2
Local	C172	0.1	0.0	0.0
Total		380.9	60.5	69.5

Table 18 SFO 2035 Baseline Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr-Dom	A-318/319/320/321	160.4	27.2	32.4
Airline-Psgr-Dom	737-700/800/900	139.2	23.6	28.1
Airline-Psgr-Dom	RJ-700	36.1	6.1	7.3
Airline-Psgr-Dom	787-9 / A-350	20.8	3.5	4.2
Airline-Psgr-Dom	DHC-8-400	19.4	3.3	4.3
Airline-Psgr-Dom	777 (all)	10.5	1.8	2.1
Airline-Psgr-Dom	EMB-170	5.7	1.0	1.2
Airline-Psgr-Intl	747 (all)	31.6	4.6	1.5
Airline-Psgr-Intl	777 (all)	17.8	2.6	0.9
Airline-Psgr-Intl	787-9 / A-350	16.8	2.4	0.8
Airline-Psgr-Intl	A-380	8.5	1.2	0.4
Airline-Psgr-Intl	A-330/340	3.5	0.5	0.2
Airline-AC	747	6.1	1.7	8.1
Airline-AC	777	1.6	0.4	2.2
Airline-AC	A330	0.2	0.0	0.2
Airline-AC	DC10/MD11	0.5	0.1	0.7
Airline-AC	767	1.0	0.3	1.3
Airline-AC	737-3/4/500	0.3	0.1	0.3
Airline-AC	737-7/8/900	0.3	0.1	0.3
GA-BJ	C750	5.4	0.5	0.5
GA-BJ	C56X	4.3	0.4	0.4
GA-BJ	GLF4	4.0	0.4	0.4
GA-BJ	H25B	3.6	0.4	0.3
GA-BJ	C560	3.4	0.3	0.3
GA-BJ	BE40	3.1	0.3	0.3
GA-BJ	CL60	2.8	0.3	0.3
GA-BJ	F2TH	2.2	0.2	0.2
GA-BJ	GALX	1.8	0.2	0.2
GA-BJ	F900	1.6	0.2	0.2
GA-BJ	CL30	1.6	0.2	0.2
GA-BJ	GLF5	1.4	0.1	0.1
GA-BJ	C550	1.3	0.1	0.1
GA-BJ	LJ60	1.1	0.1	0.1
GA-BJ	C680	1.1	0.1	0.1
GA-BJ	LJ35	1.0	0.1	0.1
GA-BJ	FA50	1.0	0.1	0.1
GA-BJ	LJ45	0.9	0.1	0.1
GA-BJ	GLEX	0.7	0.1	0.1
GA-BJ	PRM1	0.6	0.1	0.1
GA-BJ	LJ55	0.5	0.1	0.1
GA-BJ	C525	0.5	0.1	0.1
GA-BJ	C25B	0.5	0.1	0.0
GA-BJ	C650	0.4	0.0	0.0
GA-MEL	C421	1.3	0.2	0.3
GA-SEL	C182	0.2	0.0	0.0
GA-SEL	C150	0.1	0.0	0.0
GA-SEL	C172	0.1	0.0	0.0

Table 18 SFO 2035 Baseline Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-SEL	BE36	0.1	0.0	0.0
GA-TP	BE20	1.0	0.1	0.2
GA-TP	B350	0.5	0.1	0.1
GA-TP	P180	0.5	0.1	0.1
GA-TP	PAY2	0.3	0.0	0.1
GA-TP	BE30	0.3	0.0	0.1
GA-TP	BE9L	0.3	0.0	0.1
Military	C130	1.4	0.2	0.3
Military	F18	1.3	0.2	0.3
Local	C172	0.0	0.0	0.0
Total		532.5	86.3	102.5

Table 19 SFO 2035 Redistribution Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr-Dom	737-700/800/900	126.4	21.3	24.7
Airline-Psgr-Dom	777 (all)	9.5	1.6	1.9
Airline-Psgr-Dom	787-9 / A-350	18.8	3.2	3.7
Airline-Psgr-Dom	A-318/319/320/321	146.7	24.7	28.7
Airline-Psgr-Dom	DHC-8-400	17.6	3.0	3.7
Airline-Psgr-Dom	EMB-170	5.2	0.9	1.0
Airline-Psgr-Dom	RJ-700	32.8	5.5	6.4
Airline-Psgr-Intl	747 (all)	31.7	4.6	1.5
Airline-Psgr-Intl	777 (all)	17.8	2.6	0.8
Airline-Psgr-Intl	787-9 / A-350	16.9	2.4	0.8
Airline-Psgr-Intl	A-380	8.5	1.2	0.4
Airline-Psgr-Intl	A-330/340	3.5	0.5	0.2
Airline-AC	747	6.2	1.7	8.0
Airline-AC	777	1.7	0.5	2.1
Airline-AC	A330	0.2	0.1	0.2
Airline-AC	DC10/MD11	0.6	0.2	0.7
Airline-AC	767	1.0	0.3	1.3
Airline-AC	737-3/4/500	0.3	0.1	0.3
Airline-AC	737-7/8/900	0.3	0.1	0.3
GA-BJ	C750	5.4	0.5	0.5
GA-BJ	C56X	4.3	0.4	0.4
GA-BJ	GLF4	4.0	0.4	0.4
GA-BJ	H25B	3.6	0.4	0.3
GA-BJ	C560	3.5	0.3	0.3
GA-BJ	BE40	3.1	0.3	0.3
GA-BJ	CL60	2.8	0.3	0.3
GA-BJ	F2TH	2.2	0.2	0.2
GA-BJ	GALX	1.8	0.2	0.2
GA-BJ	F900	1.6	0.2	0.2
GA-BJ	CL30	1.6	0.2	0.1
GA-BJ	GLF5	1.4	0.1	0.1
GA-BJ	C550	1.4	0.1	0.1
GA-BJ	LJ60	1.1	0.1	0.1
GA-BJ	C680	1.1	0.1	0.1
GA-BJ	LJ35	1.0	0.1	0.1
GA-BJ	FA50	1.0	0.1	0.1
GA-BJ	LJ45	0.9	0.1	0.1
GA-BJ	GLEX	0.7	0.1	0.1
GA-BJ	PRM1	0.6	0.1	0.1
GA-BJ	LJ55	0.5	0.1	0.0
GA-BJ	C525	0.5	0.1	0.0
GA-BJ	C25B	0.5	0.1	0.0
GA-BJ	C650	0.4	0.0	0.0
GA-MEL	C421	1.3	0.2	0.3
GA-SEL	C182	0.2	0.0	0.0
GA-SEL	C150	0.1	0.0	0.0
GA-SEL	C172	0.1	0.0	0.0

Table 19 SFO 2035 Redistribution Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-SEL	BE36	0.1	0.0	0.0
GA-TP	BE20	1.0	0.1	0.2
GA-TP	B350	0.5	0.1	0.1
GA-TP	P180	0.5	0.1	0.1
GA-TP	PAY2	0.3	0.0	0.1
GA-TP	BE30	0.3	0.0	0.1
GA-TP	BE9L	0.3	0.0	0.1
Military	C130	1.4	0.2	0.3
Military	F18	1.3	0.2	0.3
Local	C172	0.0	0.0	0.0
Total		498.0	79.8	92.4

Table 20 SFO 2035 Internal Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr-Dom	A-318/319/320/321	156.6	26.5	31.4
Airline-Psgr-Dom	737-700/800/900	135.6	23.0	27.2
Airline-Psgr-Dom	RJ-700	35.4	6.0	7.1
Airline-Psgr-Dom	787-9 / A-350	20.3	3.4	4.1
Airline-Psgr-Dom	DHC-8-400	18.9	3.2	4.1
Airline-Psgr-Dom	777 (all)	10.2	1.7	2.0
Airline-Psgr-Dom	EMB-170	5.4	0.9	1.1
Airline-Psgr-Intl	747 (all)	31.6	4.6	1.5
Airline-Psgr-Intl	777 (all)	17.8	2.6	0.9
Airline-Psgr-Intl	787-9 / A-350	16.8	2.4	0.8
Airline-Psgr-Intl	A-380	8.5	1.2	0.4
Airline-Psgr-Intl	A-330/340	3.5	0.5	0.2
Airline-AC	747	6.1	1.7	8.1
Airline-AC	777	1.6	0.5	2.2
Airline-AC	A330	0.2	0.1	0.2
Airline-AC	DC10/MD11	0.5	0.1	0.7
Airline-AC	767	1.0	0.3	1.3
Airline-AC	737-3/4/500	0.3	0.1	0.3
Airline-AC	737-7/8/900	0.3	0.1	0.3
GA-BJ	C750	5.4	0.5	0.5
GA-BJ	C56X	4.3	0.4	0.4
GA-BJ	GLF4	4.0	0.4	0.4
GA-BJ	H25B	3.6	0.4	0.3
GA-BJ	C560	3.4	0.3	0.3
GA-BJ	BE40	3.1	0.3	0.3
GA-BJ	CL60	2.8	0.3	0.3
GA-BJ	F2TH	2.2	0.2	0.2
GA-BJ	GALX	1.8	0.2	0.2
GA-BJ	F900	1.6	0.2	0.2
GA-BJ	CL30	1.6	0.2	0.2
GA-BJ	GLF5	1.4	0.1	0.1
GA-BJ	C550	1.4	0.1	0.1
GA-BJ	LJ60	1.1	0.1	0.1
GA-BJ	C680	1.1	0.1	0.1
GA-BJ	LJ35	1.0	0.1	0.1
GA-BJ	FA50	1.0	0.1	0.1
GA-BJ	LJ45	0.9	0.1	0.1
GA-BJ	GLEX	0.7	0.1	0.1
GA-BJ	PRM1	0.6	0.1	0.1
GA-BJ	LJ55	0.5	0.1	0.1
GA-BJ	C525	0.5	0.1	0.0
GA-BJ	C25B	0.5	0.1	0.0
GA-BJ	C650	0.4	0.0	0.0
GA-MEL	C421	1.3	0.2	0.3
GA-SEL	C182	0.2	0.0	0.0
GA-SEL	C150	0.1	0.0	0.0
GA-SEL	C172	0.1	0.0	0.0

Table 20 SFO 2035 Internal Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-SEL	BE36	0.1	0.0	0.0
GA-TP	BE20	1.0	0.1	0.2
GA-TP	B350	0.5	0.1	0.1
GA-TP	P180	0.5	0.1	0.1
GA-TP	PAY2	0.3	0.0	0.1
GA-TP	BE30	0.3	0.0	0.1
GA-TP	BE9L	0.3	0.0	0.1
Military	C130	1.4	0.2	0.3
Military	F18	1.3	0.2	0.3
Local	C172	0.0	0.0	0.0
Total		444.0	71.1	83.9

Table 21 SFO 2035 External Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr-Dom	A-318/319/320/321	159.0	27.0	32.0
Airline-Psgr-Dom	737-700/800/900	137.9	23.4	27.7
Airline-Psgr-Dom	RJ-700	36.0	6.1	7.2
Airline-Psgr-Dom	787-9 / A-350	20.6	3.5	4.2
Airline-Psgr-Dom	DHC-8-400	19.2	3.2	4.2
Airline-Psgr-Dom	777 (all)	10.4	1.8	2.1
Airline-Psgr-Dom	EMB-170	5.5	0.9	1.1
Airline-Psgr-Intl	747 (all)	31.6	4.6	1.5
Airline-Psgr-Intl	777 (all)	17.8	2.6	0.9
Airline-Psgr-Intl	787-9 / A-350	16.8	2.4	0.8
Airline-Psgr-Intl	A-380	8.5	1.2	0.4
Airline-Psgr-Intl	A-330/340	3.5	0.5	0.2
Airline-AC	747	6.1	1.7	8.1
Airline-AC	777	1.6	0.4	2.2
Airline-AC	A330	0.2	0.0	0.2
Airline-AC	DC10/MD11	0.5	0.1	0.7
Airline-AC	767	1.0	0.3	1.3
Airline-AC	737-3/4/500	0.3	0.1	0.3
Airline-AC	737-7/8/900	0.3	0.1	0.3
GA-BJ	C750	5.4	0.5	0.5
GA-BJ	C56X	4.3	0.4	0.4
GA-BJ	GLF4	4.0	0.4	0.4
GA-BJ	H25B	3.6	0.4	0.3
GA-BJ	C560	3.4	0.3	0.3
GA-BJ	BE40	3.1	0.3	0.3
GA-BJ	CL60	2.8	0.3	0.3
GA-BJ	F2TH	2.2	0.2	0.2
GA-BJ	GALX	1.8	0.2	0.2
GA-BJ	F900	1.6	0.2	0.2
GA-BJ	CL30	1.6	0.2	0.2
GA-BJ	GLF5	1.4	0.1	0.1
GA-BJ	C550	1.3	0.1	0.1
GA-BJ	LJ60	1.1	0.1	0.1
GA-BJ	C680	1.1	0.1	0.1
GA-BJ	LJ35	1.0	0.1	0.1
GA-BJ	FA50	1.0	0.1	0.1
GA-BJ	LJ45	0.9	0.1	0.1
GA-BJ	GLEX	0.7	0.1	0.1
GA-BJ	PRM1	0.6	0.1	0.1
GA-BJ	LJ55	0.5	0.1	0.1
GA-BJ	C525	0.5	0.1	0.0
GA-BJ	C25B	0.5	0.1	0.0
GA-BJ	C650	0.4	0.0	0.0
GA-MEL	C421	1.3	0.2	0.3
GA-SEL	C182	0.2	0.0	0.0
GA-SEL	C150	0.1	0.0	0.0
GA-SEL	C172	0.1	0.0	0.0

Table 21 SFO 2035 External Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-SEL	BE36	0.1	0.0	0.0
GA-TP	BE20	1.0	0.1	0.2
GA-TP	B350	0.5	0.1	0.1
GA-TP	P180	0.5	0.1	0.1
GA-TP	PAY2	0.3	0.0	0.1
GA-TP	BE30	0.3	0.0	0.1
GA-TP	BE9L	0.3	0.0	0.1
Military	C130	1.4	0.2	0.3
Military	F18	1.3	0.2	0.3
Local	C172	0.0	0.0	0.0
Total		529.1	85.5	101.4

Table 22 SFO 2035 Air Traffic Control Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr-Dom	A-318/319/320/321	162.2	27.1	30.8
Airline-Psgr-Dom	737-700/800/900	140.7	23.5	26.7
Airline-Psgr-Dom	RJ-700	36.5	6.1	6.9
Airline-Psgr-Dom	787-9 / A-350	21.1	3.5	4.0
Airline-Psgr-Dom	DHC-8-400	19.7	3.3	3.9
Airline-Psgr-Dom	777 (all)	10.6	1.8	2.0
Airline-Psgr-Dom	EMB-170	5.8	1.0	1.1
Airline-Psgr-Intl	747 (all)	31.7	4.5	1.4
Airline-Psgr-Intl	777 (all)	17.9	2.5	0.8
Airline-Psgr-Intl	787-9 / A-350	16.9	2.4	0.8
Airline-Psgr-Intl	A-380	8.5	1.2	0.4
Airline-Psgr-Intl	A-330/340	3.5	0.5	0.2
Airline-AC	747	6.3	1.7	7.9
Airline-AC	777	1.7	0.5	2.1
Airline-AC	A330	0.2	0.1	0.2
Airline-AC	DC10/MD11	0.6	0.2	0.7
Airline-AC	767	1.0	0.3	1.3
Airline-AC	737-3/4/500	0.3	0.1	0.3
Airline-AC	737-7/8/900	0.3	0.1	0.3
GA-BJ	C750	5.4	0.5	0.5
GA-BJ	C56X	4.3	0.4	0.4
GA-BJ	GLF4	4.0	0.4	0.4
GA-BJ	H25B	3.6	0.4	0.3
GA-BJ	C560	3.5	0.3	0.3
GA-BJ	BE40	3.1	0.3	0.3
GA-BJ	CL60	2.8	0.3	0.3
GA-BJ	F2TH	2.2	0.2	0.2
GA-BJ	GALX	1.8	0.2	0.2
GA-BJ	F900	1.6	0.2	0.1
GA-BJ	CL30	1.6	0.2	0.1
GA-BJ	GLF5	1.4	0.1	0.1
GA-BJ	C550	1.4	0.1	0.1
GA-BJ	LJ60	1.1	0.1	0.1
GA-BJ	C680	1.1	0.1	0.1
GA-BJ	LJ35	1.0	0.1	0.1
GA-BJ	FA50	1.0	0.1	0.1
GA-BJ	LJ45	0.9	0.1	0.1
GA-BJ	GLEX	0.7	0.1	0.1
GA-BJ	PRM1	0.6	0.1	0.1
GA-BJ	LJ55	0.5	0.1	0.0
GA-BJ	C525	0.5	0.1	0.0
GA-BJ	C25B	0.5	0.1	0.0
GA-BJ	C650	0.4	0.0	0.0
GA-MEL	C421	1.3	0.2	0.3
GA-SEL	C182	0.2	0.0	0.0
GA-SEL	C150	0.1	0.0	0.0
GA-SEL	C172	0.1	0.0	0.0

Table 22 SFO 2035 Air Traffic Control Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-SEL	BE36	0.1	0.0	0.0
GA-TP	BE20	1.0	0.1	0.2
GA-TP	B350	0.5	0.1	0.1
GA-TP	P180	0.5	0.1	0.1
GA-TP	PAY2	0.3	0.0	0.1
GA-TP	BE30	0.3	0.0	0.1
GA-TP	BE9L	0.3	0.0	0.1
Military	C130	1.4	0.2	0.3
Military	F18	1.3	0.2	0.2
Local	C172	0.0	0.0	0.0
Total		538.1	85.9	97.4

Table 23 SFO 2035 High Speed Rail Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr-Dom	A-318/319/320/321	151.33	25.56	29.88
Airline-Psgr-Dom	737-700/800/900	130.33	22.02	25.73
Airline-Psgr-Dom	RJ-700	33.55	5.67	6.62
Airline-Psgr-Dom	787-9 / A-350	20.93	3.54	4.13
Airline-Psgr-Dom	DHC-8-400	16.61	2.80	3.53
Airline-Psgr-Dom	777 (all)	10.56	1.78	2.08
Airline-Psgr-Dom	EMB-170	2.62	0.44	0.52
Airline-Psgr-Intl	747 (all)	31.66	4.56	1.50
Airline-Psgr-Intl	777 (all)	17.83	2.57	0.84
Airline-Psgr-Intl	787-9 / A-350	16.84	2.43	0.80
Airline-Psgr-Intl	A-380	8.48	1.22	0.40
Airline-Psgr-Intl	A-330/340	3.54	0.51	0.17
Airline-AC	747	6.19	1.69	8.02
Airline-AC	777	1.66	0.45	2.15
Airline-AC	A330	0.18	0.05	0.24
Airline-AC	DC10/MD11	0.55	0.15	0.71
Airline-AC	767	1.00	0.27	1.29
Airline-AC	737-3/4/500	0.27	0.07	0.34
Airline-AC	737-7/8/900	0.27	0.07	0.34
GA-BJ	C750	5.38	0.54	0.51
GA-BJ	C56X	4.29	0.43	0.40
GA-BJ	GLF4	4.00	0.40	0.38
GA-BJ	H25B	3.63	0.36	0.34
GA-BJ	C560	3.45	0.34	0.32
GA-BJ	BE40	3.06	0.31	0.29
GA-BJ	CL60	2.82	0.28	0.27
GA-BJ	F2TH	2.21	0.22	0.21
GA-BJ	GALX	1.84	0.18	0.17
GA-BJ	F900	1.63	0.16	0.15
GA-BJ	CL30	1.58	0.16	0.15
GA-BJ	GLF5	1.40	0.14	0.13
GA-BJ	C550	1.35	0.14	0.13
GA-BJ	LJ60	1.10	0.11	0.10
GA-BJ	C680	1.10	0.11	0.10
GA-BJ	LJ35	0.99	0.10	0.09
GA-BJ	FA50	0.97	0.10	0.09
GA-BJ	LJ45	0.93	0.09	0.09
GA-BJ	GLEX	0.71	0.07	0.07
GA-BJ	PRM1	0.61	0.06	0.06
GA-BJ	LJ55	0.53	0.05	0.05
GA-BJ	C525	0.52	0.05	0.05
GA-BJ	C25B	0.51	0.05	0.05
GA-BJ	C650	0.45	0.04	0.04
GA-MEL	C421	1.27	0.18	0.27
GA-SEL	C182	0.17	0.02	0.04
GA-SEL	C150	0.10	0.01	0.02
GA-SEL	C172	0.08	0.01	0.02

Table 23 SFO 2035 High Speed Rail Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-SEL	BE36	0.06	0.01	0.01
GA-TP	BE20	1.00	0.14	0.21
GA-TP	B350	0.48	0.07	0.10
GA-TP	P180	0.46	0.06	0.10
GA-TP	PAY2	0.32	0.05	0.07
GA-TP	BE30	0.30	0.04	0.06
GA-TP	BE9L	0.30	0.04	0.06
Military	C130	1.41	0.24	0.30
Military	F18	1.28	0.22	0.25
Local	C172	0.00	0.00	0.00
Total		506.69	81.45	95.07

Table 24 SFO 2035 Demand Management Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr-Dom	737-700/800/900	139.7	23.6	27.6
Airline-Psgr-Dom	777 (all)	10.6	1.8	2.1
Airline-Psgr-Dom	787-9 / A-350	20.9	3.5	4.1
Airline-Psgr-Dom	A-318/319/320/321	161.0	27.2	31.8
Airline-Psgr-Dom	DHC-8-400	8.9	1.5	1.9
Airline-Psgr-Dom	EMB-170	3.7	0.6	0.7
Airline-Psgr-Dom	EMB-190	13.1	2.2	2.6
Airline-Psgr-Dom	RJ-700	24.2	4.1	4.8
Airline-Psgr-Intl	747 (all)	31.7	4.6	1.5
Airline-Psgr-Intl	777 (all)	17.8	2.6	0.8
Airline-Psgr-Intl	787-9 / A-350	16.8	2.4	0.8
Airline-Psgr-Intl	A-330/340	3.5	0.5	0.2
Airline-Psgr-Intl	A-380	8.5	1.2	0.4
Airline-AC	747	6.2	1.7	8.0
Airline-AC	777	1.7	0.5	2.2
Airline-AC	A330	0.2	0.1	0.2
Airline-AC	DC10/MD11	0.6	0.1	0.7
Airline-AC	767	1.0	0.3	1.3
Airline-AC	737-3/4/500	0.3	0.1	0.3
Airline-AC	737-7/8/900	0.3	0.1	0.3
GA-BJ	C750	4.2	0.4	0.4
GA-BJ	C56X	3.3	0.3	0.3
GA-BJ	GLF4	3.1	0.3	0.3
GA-BJ	H25B	2.8	0.3	0.3
GA-BJ	C560	2.7	0.3	0.3
GA-BJ	BE40	2.4	0.2	0.2
GA-BJ	CL60	2.2	0.2	0.2
GA-BJ	F2TH	1.7	0.2	0.2
GA-BJ	GALX	1.4	0.1	0.1
GA-BJ	F900	1.3	0.1	0.1
GA-BJ	CL30	1.2	0.1	0.1
GA-BJ	GLF5	1.1	0.1	0.1
GA-BJ	C550	1.1	0.1	0.1
GA-BJ	LJ60	0.9	0.1	0.1
GA-BJ	C680	0.9	0.1	0.1
GA-BJ	LJ35	0.8	0.1	0.1
GA-BJ	FA50	0.8	0.1	0.1
GA-BJ	LJ45	0.7	0.1	0.1
GA-BJ	GLEX	0.6	0.1	0.1
GA-BJ	PRM1	0.5	0.0	0.0
GA-BJ	LJ55	0.4	0.0	0.0
GA-BJ	C525	0.4	0.0	0.0
GA-BJ	C25B	0.4	0.0	0.0
GA-BJ	C650	0.3	0.0	0.0
GA-MEL	C421	1.0	0.1	0.2
GA-SEL	C182	0.1	0.0	0.0
GA-SEL	C150	0.1	0.0	0.0

Table 24 SFO 2035 Demand Management Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-SEL	C172	0.1	0.0	0.0
GA-SEL	BE36	0.1	0.0	0.0
GA-TP	BE20	0.8	0.1	0.2
GA-TP	B350	0.4	0.1	0.1
GA-TP	P180	0.4	0.1	0.1
GA-TP	PAY2	0.3	0.0	0.1
GA-TP	BE30	0.2	0.0	0.1
GA-TP	BE9L	0.2	0.0	0.1
Military	C130	1.4	0.2	0.3
Military	F18	1.3	0.2	0.3
Local	C172	0.0	0.0	0.0
Total		512.0	83.1	97.1

Table 25 SJC 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-300	28.7	8.0	2.8
Airline-Psgr	737-400/500	3.5	1.0	0.3
Airline-Psgr	737-700/800/900	34.6	9.7	3.4
Airline-Psgr	757 (all)	3.3	0.9	0.3
Airline-Psgr	767 (all)	0.7	0.2	0.1
Airline-Psgr	A-318/319/320/321	14.4	4.0	1.4
Airline-Psgr	DHC-8-100	0.0	0.0	0.0
Airline-Psgr	DHC-8-400	2.0	0.6	0.2
Airline-Psgr	EMB-120	3.0	0.8	0.3
Airline-Psgr	EMB-140	16.6	4.6	1.6
Airline-Psgr	EMB-145/ERJ-145	1.5	0.4	0.1
Airline-Psgr	EMB-170	0.2	0.1	0.0
Airline-Psgr	EMB-190	0.0	0.0	0.0
Airline-Psgr	MD-80 (all)	11.6	3.2	1.1
Airline-Psgr	RJ-200/ER	4.7	1.3	0.5
Airline-Psgr	RJ-700	1.6	0.4	0.2
Airline-Psgr	RJ-900	0.8	0.2	0.1
Airline-Psgr	SF-340	0.0	0.0	0.0
Airline-AC	DC10/MD11	0.8	0.3	0.1
Airline-AC	A300	0.3	0.1	0.0
Airline-AC	767 (all)	0.9	0.4	0.1
Airline-AC	757 (all)	0.3	0.1	0.0
Airline-AC	DC8	0.4	0.2	0.0
Airline-AC	DC9	0.0	0.0	0.0
Airline-AC	737-200/300	0.0	0.0	0.0
GA-BJ	ASTR	0.3	0.0	0.0
GA-BJ	BE40	2.7	0.3	0.3
GA-BJ	C525	0.8	0.1	0.1
GA-BJ	C550	1.0	0.1	0.1
GA-BJ	C560	2.6	0.3	0.3
GA-BJ	C56X	2.8	0.3	0.3
GA-BJ	C650	0.5	0.1	0.1
GA-BJ	C680	0.5	0.1	0.1
GA-BJ	C750	3.1	0.4	0.4
GA-BJ	CL30	1.0	0.1	0.1
GA-BJ	CL60	1.2	0.1	0.1
GA-BJ	F2TH	2.0	0.3	0.3
GA-BJ	F900	1.4	0.2	0.2
GA-BJ	FA50	0.4	0.1	0.1
GA-BJ	GALX	1.0	0.1	0.1
GA-BJ	GL5T	0.3	0.0	0.0
GA-BJ	GLEK	0.6	0.1	0.1
GA-BJ	GLF3	0.4	0.0	0.0
GA-BJ	GLF4	2.6	0.3	0.3
GA-BJ	GLF5	1.5	0.2	0.2
GA-BJ	H25B	2.1	0.3	0.3
GA-BJ	LJ35	0.5	0.1	0.1

Table 25 SJC 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
GA-BJ	LJ45	0.4	0.0	0.0
GA-BJ	LJ60	0.7	0.1	0.1
GA-BJ	PRM1	0.5	0.1	0.1
GA-BJ	SBR1	0.3	0.0	0.0
GA-BJ	WW24	0.3	0.0	0.0
GA-MEL	BE55	0.3	0.0	0.0
GA-MEL	BE60	0.2	0.0	0.0
GA-MEL	BE95	0.9	0.1	0.0
GA-MEL	C206	0.5	0.0	0.0
GA-MEL	C310	0.7	0.1	0.0
GA-MEL	C414	0.4	0.0	0.0
GA-MEL	C421	0.4	0.0	0.0
GA-MEL	PA34	0.4	0.0	0.0
GA-SEL	BE35	1.4	0.1	0.1
GA-SEL	BE36	0.9	0.1	0.0
GA-SEL	C172	2.9	0.2	0.1
GA-SEL	C182	0.8	0.1	0.0
GA-SEL	C210	0.8	0.1	0.0
GA-SEL	P28A	0.6	0.0	0.0
GA-SEL	SR22	0.6	0.1	0.0
GA-TP	AC90	1.1	0.1	0.0
GA-TP	B350	2.2	0.2	0.1
GA-TP	BE20	3.0	0.2	0.1
GA-TP	BE30	1.6	0.1	0.1
GA-TP	BE9L	1.2	0.1	0.1
GA-TP	C425	0.5	0.0	0.0
GA-TP	C441	0.4	0.0	0.0
GA-TP	D328	0.4	0.0	0.0
GA-TP	DHC6	2.1	0.2	0.1
GA-TP	P180	2.8	0.2	0.1
GA-TP	PAY2	0.3	0.0	0.0
GA-TP	PC12	2.6	0.2	0.1
Military	T33	0.1	0.0	0.0
Military	C130	0.0	0.0	0.0
Local	C152	7.0	0.6	0.3
Local	C172	5.7	0.5	0.3
Local	PA18	6.3	0.5	0.3
Total		210.3	44.4	18.9

Table 26 SJC 2035 Baseline Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	77.7	21.7	7.6
Airline-Psgr	A-318/319/320/321	57.8	16.1	5.6
Airline-Psgr	RJ-700	16.9	4.7	1.6
Airline-AC	DC10/MD11	0.3	0.1	0.0
Airline-AC	A300	0.1	0.0	0.0
Airline-AC	777	0.8	0.3	0.1
Airline-AC	A330	0.2	0.1	0.0
Airline-AC	767	1.1	0.5	0.1
Airline-AC	757	0.9	0.4	0.1
GA-BJ	GLF4	9.7	1.2	1.2
GA-BJ	LJ35	38.8	4.9	4.9
GA-MEL	BE58	2.1	0.2	0.1
GA-SEL	C172	8.2	0.7	0.4
GA-TP	C441	20.0	1.6	0.9
Military	T33	0.1	0.0	0.0
Military	C130	0.0	0.0	0.0
Local	C152	7.5	0.6	0.4
Local	C172	6.1	0.5	0.3
Local	PA18	6.7	0.5	0.3
Total		254.9	54.0	23.6

Note: The 2035 SJC Demand Management scenario is the same as the 2035 Baseline scenario.

Table 27 SJC 2035 Redistribution Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	87.3	24.3	8.5
Airline-Psgr	A-318/319/320/321	64.0	17.9	6.3
Airline-Psgr	RJ-700	18.9	5.3	1.9
Airline-AC	DC10/MD11	0.3	0.1	0.0
Airline-AC	A300	0.1	0.0	0.0
Airline-AC	777	0.8	0.3	0.1
Airline-AC	A330	0.2	0.1	0.0
Airline-AC	767	1.1	0.5	0.1
Airline-AC	757	0.9	0.4	0.1
GA-BJ	GLF4	9.7	1.2	1.2
GA-BJ	LJ35	38.8	4.9	4.9
GA-MEL	BE58	2.1	0.2	0.1
GA-SEL	C172	8.2	0.7	0.4
GA-TP	C441	20.0	1.6	0.9
Military	T33	0.1	0.0	0.0
Military	C130	0.0	0.0	0.0
Local	C152	7.5	0.6	0.4
Local	C172	6.1	0.5	0.3
Local	PA18	6.7	0.5	0.3
Total		272.8	59.0	25.4

Table 28 SJC 2035 Internal Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	77.4	21.6	7.6
Airline-Psgr	A-318/319/320/321	57.6	16.1	5.6
Airline-Psgr	RJ-700	16.8	4.7	1.6
Airline-AC	DC10/MD11	0.3	0.1	0.0
Airline-AC	A300	0.1	0.0	0.0
Airline-AC	777	0.8	0.3	0.1
Airline-AC	A330	0.2	0.1	0.0
Airline-AC	767	1.1	0.5	0.1
Airline-AC	757	0.9	0.4	0.1
GA-BJ	GLF4	9.7	1.2	1.2
GA-BJ	LJ35	38.8	4.9	4.9
GA-MEL	BE58	2.1	0.2	0.1
GA-SEL	C172	8.2	0.7	0.4
GA-TP	C441	20.0	1.6	0.9
Military	T33	0.1	0.0	0.0
Military	C130	0.0	0.0	0.0
Local	C152	7.5	0.6	0.4
Local	C172	6.1	0.5	0.3
Local	PA18	6.7	0.5	0.3
Total		254.4	53.8	23.6

Table 29 SJC 2035 External Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	73.7	20.6	7.2
Airline-Psgr	A-318/319/320/321	55.2	15.4	5.4
Airline-Psgr	RJ-700	16.0	4.5	1.6
Airline-AC	DC10/MD11	0.3	0.1	0.0
Airline-AC	A300	0.1	0.0	0.0
Airline-AC	777	0.8	0.3	0.1
Airline-AC	A330	0.2	0.1	0.0
Airline-AC	767	1.1	0.5	0.1
Airline-AC	757	0.9	0.4	0.1
GA-BJ	GLF4	9.7	1.2	1.2
GA-BJ	LJ35	38.8	4.9	4.9
GA-MEL	BE58	2.1	0.2	0.1
GA-SEL	C172	8.2	0.7	0.4
GA-TP	C441	20.0	1.6	0.9
Military	T33	0.1	0.0	0.0
Military	C130	0.0	0.0	0.0
Local	C152	7.5	0.6	0.4
Local	C172	6.1	0.5	0.3
Local	PA18	6.7	0.5	0.3
Total		247.5	51.9	22.9

Table 30 SJC 2035 Air Traffic Control Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	77.7	21.7	7.6
Airline-Psgr	A-318/319/320/321	57.8	16.1	5.6
Airline-Psgr	RJ-700	16.9	4.7	1.6
Airline-AC	DC10/MD11	0.3	0.1	0.0
Airline-AC	A300	0.1	0.0	0.0
Airline-AC	777	0.8	0.3	0.1
Airline-AC	A330	0.2	0.1	0.0
Airline-AC	767	1.1	0.5	0.1
Airline-AC	757	0.9	0.4	0.1
GA-BJ	GLF4	9.7	1.2	1.2
GA-BJ	LJ35	38.8	4.9	4.9
GA-MEL	BE58	2.1	0.2	0.1
GA-SEL	C172	8.2	0.7	0.4
GA-TP	C441	20.0	1.6	0.9
Military	T33	0.1	0.0	0.0
Military	C130	0.0	0.0	0.0
Local	C152	7.5	0.6	0.4
Local	C172	6.1	0.5	0.3
Local	PA18	6.7	0.5	0.3
Total		254.9	54.0	23.6

Table 31 SJC 2035 High Speed Rail Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
Airline-Psgr	737-700/800/900	64.2	17.9	6.3
Airline-Psgr	A-318/319/320/321	49.0	13.7	4.8
Airline-Psgr	RJ-700	16.9	4.7	1.6
Airline-AC	DC10/MD11	0.3	0.1	0.0
Airline-AC	A300	0.1	0.0	0.0
Airline-AC	777	0.8	0.3	0.1
Airline-AC	A330	0.2	0.1	0.0
Airline-AC	767	1.1	0.5	0.1
Airline-AC	757	0.9	0.4	0.1
GA-BJ	GLF4	9.7	1.2	1.2
GA-BJ	LJ35	38.8	4.9	4.9
GA-MEL	BE58	2.1	0.2	0.1
GA-SEL	C172	8.2	0.7	0.4
GA-TP	C441	20.0	1.6	0.9
Military	T33	0.1	0.0	0.0
Military	C130	0.0	0.0	0.0
Local	C152	7.5	0.6	0.4
Local	C172	6.1	0.5	0.3
Local	PA18	6.7	0.5	0.3
Total		232.6	47.8	21.5

Table 32 CCR 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
	BEC190	1.4	0.1	0.1
	BEC58P	13.5	1.3	0.1
	BEC9F	0.7	0.0	0.1
	CIT3	2.0	0.1	0.0
	CL600	0.9	0.1	0.0
	CNA172	17.5	0.1	0.0
	CNA206	7.6	0.6	0.1
	CNA20T	21.6	1.6	0.3
	CNA441	1.9	0.1	0.1
	CNA500	0.4	0.0	0.0
	CNA55B	6.2	0.4	0.1
	CNA750	0.5	0.0	0.0
	DHC6	14.8	0.8	1.4
	DHC830	0.0	0.0	0.0
	DHC8	0.4	0.0	0.0
	FAL20	0.1	0.0	0.0
	GASEPF	13.6	0.0	0.0
	GASEPV	52.5	2.4	0.5
	GIIB	0.0	0.0	0.0
	GIV	0.9	0.1	0.0
	HS748A	0.2	0.0	0.0
	IA1125	1.2	0.1	0.0
	LEAR25	0.0	0.0	0.0
	LEAR35	2.1	0.1	0.0
	MU3001	0.4	0.0	0.0
	SABR80	1.0	0.0	0.0
	CRJ-700	0.0	0.0	0.0
Total		161.4	8.1	169.5

Table 33 CCR 2035 Baseline Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
	BEC190	1.4	0.1	0.1
	BEC58P	14.4	0.1	0.1
	BEC9F	0.8	0.1	0.1
	CIT3	2.1	0.0	0.0
	CL600	1.0	0.0	0.0
	CNA172	18.6	0.0	0.0
	CNA206	8.1	0.1	0.1
	CNA20T	22.9	0.4	0.4
	CNA441	2.0	0.1	0.1
	CNA500	0.4	0.0	0.0
	CNA55B	6.6	0.1	0.1
	CNA750	0.6	0.0	0.0
	DHC6	15.7	1.5	1.5
	DHC830	0.0	0.0	0.0
	DHC8	0.5	0.0	0.0
	FAL20	0.1	0.0	0.0
	GASEPF	14.4	0.0	0.0
	GASEPV	55.9	0.5	0.5
	GIIB	0.0	0.0	0.0
	GIV	0.9	0.0	0.0
	HS748A	0.2	0.0	0.0
	IA1125	1.3	0.0	0.0
	LEAR25	0.0	0.0	0.0
	LEAR35	2.2	0.0	0.0
	MU3001	0.5	0.0	0.0
	SABR80	1.1	0.0	0.0
	CRJ-700	0.0	0.0	0.0
Total		183.4	171.6	3.1

Note: These operations are used for CCR for all 2035 scenarios with the exception of the Internal Regional Airports scenario.

Table 34 CCR 2035 Internal Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
	BEC190	1.4	0.1	0.1
	BEC58P	14.4	1.3	0.1
	BEC9F	0.8	0.0	0.1
	CIT3	2.1	0.1	0.0
	CL600	1.0	0.1	0.0
	CNA172	18.6	0.1	0.0
	CNA206	8.1	0.7	0.1
	CNA20T	22.9	1.7	0.4
	CNA441	2.0	0.2	0.1
	CNA500	0.4	0.0	0.0
	CNA55B	6.6	0.5	0.1
	CNA750	0.6	0.0	0.0
	DHC6	15.7	0.8	1.5
	DHC830	0.0	0.0	0.0
	DHC8	0.5	0.0	0.0
	FAL20	0.1	0.0	0.0
	GASEPF	14.4	0.0	0.0
	GASEPV	55.9	2.5	0.5
	GIIB	0.0	0.0	0.0
	GIV	0.9	0.1	0.0
	HS748A	0.2	0.0	0.0
	IA1125	1.3	0.1	0.0
	LEAR25	0.0	0.0	0.0
	LEAR35	2.2	0.1	0.0
	MU3001	0.5	0.0	0.0
	SABR80	1.1	0.0	0.0
	CRJ-700	27.5	1.4	0.5
Total		199.2	10.0	3.6

Table 35 STS 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
	Q-400—Twin-engine prop	1.3	0.3	0.3
	Single-engine, Fixed	61.1	5.1	1.7
	Single-engine, Variable	41.0	3.4	1.1
	Twin-engine, Piston	22.3	1.9	0.6
	Twin-engine, Turboprop	5.1	0.4	0.1
	Piaggio Twin-engine prop	1.7	0.1	0.0
	Beech 400	5.0	0.4	0.1
	Gulfstream III	0.3	0.0	0.0
	Gulfstream IV	0.1	0.0	0.0
	Gulfstream V	0.1	0.0	0.0
	Falcon 50	0.1	0.0	0.0
	Falcon 900	0.3	0.0	0.0
	Hawker H25	0.6	0.0	0.0
	Cessna 550	5.0	0.4	0.1
	Cessna 650	1.0	0.1	0.0
	Cessna 750	2.0	0.2	0.1
	Challenger 600	0.2	0.0	0.0
	Lear 45	0.3	0.0	0.0
	Lear 60	0.3	0.0	0.0
	B206L	5.0	0.4	0.1
	A109	5.0	0.4	0.1
	A109 - Helicopter	0.6	0.0	0.0
Total		158.4	13.4	4.7

Table 36 STS 2035 Baseline Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
	Boeing 737-700	2.0	0.2	0.1
	EMB-170-RJ	1.5	0.1	0.0
	EMB-190-RJ	1.9	0.2	0.1
	CRJ-700-RJ	1.5	0.1	0.0
	CRJ-900-RJ	1.6	0.1	0.0
	Q-400-Twin-engine prop	4.9	0.4	0.1
	Single-engine, Fixed	79.2	6.6	2.2
	Single-engine, Variable	51.5	4.3	1.4
	Twin-engine, Piston	29.2	2.4	0.8
	Twin-engine, Turboprop	7.1	0.6	0.2
	Piaggio-Twin-engine prop	3.7	0.3	0.1
	Beech 400	10.5	0.9	0.3
	Gulfstream III	0.3	0.0	0.0
	Gulfstream IV	0.3	0.0	0.0
	Gulfstream V	0.3	0.0	0.0
	Falcon 50	0.3	0.0	0.0
	Falcon 900	0.6	0.0	0.0
	Hawker H25	1.2	0.1	0.0
	Cessna 550	7.9	0.7	0.2
	Cessna 650	2.1	0.2	0.1
	Cessna 750	4.2	0.3	0.1
	Challenger 600	0.4	0.0	0.0
	Lear 45	0.6	0.0	0.0
	Lear 60	0.6	0.0	0.0
	Very Light jets (VLJ)	15.7	1.3	0.4
	B206L	5.8	0.5	0.2
	A109	5.8	0.5	0.2
	A109	0.6	0.1	0.0
Total		241.3	20.1	6.7

Note: These operations are used for STS for all 2035 scenarios with the exception of the Internal Regional Airports scenario.

Table 37 STS 2035 Internal Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
	Boeing 737-700	2.0	0.2	0.1
	EMB-170-RJ	1.5	0.1	0.0
	EMB-190-RJ	1.9	0.2	0.1
	CRJ-700-RJ	14.4	1.2	0.4
	CRJ-900-RJ	1.6	0.1	0.0
	Q-400-Twin-engine prop	4.9	0.4	0.1
	Single-engine, Fixed	79.2	6.6	2.2
	Single-engine, Variable	51.5	4.3	1.4
	Twin-engine, Piston	29.2	2.4	0.8
	Twin-engine, Turboprop	7.1	0.6	0.2
	Piaggio-Twin-engine prop	3.7	0.3	0.1
	Beech 400	10.5	0.9	0.3
	Gulfstream III	0.3	0.0	0.0
	Gulfstream IV	0.3	0.0	0.0
	Gulfstream V	0.3	0.0	0.0
	Falcon 50	0.3	0.0	0.0
	Falcon 900	0.6	0.0	0.0
	Hawker H25	1.2	0.1	0.0
	Cessna 550	7.9	0.7	0.2
	Cessna 650	2.1	0.2	0.1
	Cessna 750	4.2	0.3	0.1
	Challenger 600	0.4	0.0	0.0
	Lear 45	0.6	0.0	0.0
	Lear 60	0.6	0.0	0.0
	Very Light jets (VLJ)	15.7	1.3	0.4
	B206L	5.8	0.5	0.2
	A109	5.8	0.5	0.2
	A109	0.6	0.1	0.0
Total		254.1	21.2	7.1

Table 38 SUU 2007 Existing Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
	C-141A	0.9	0.0	0.0
	C-5A	24.4	6.1	3.7
	KC-10A	33.4	5.7	3.4
	KC-135R	5.7	0.9	0.2
	T-38A	0.9	0.0	0.0
	CRJ-700	0.0	0.0	0.0
Total		65.2	12.6	7.3

Note: These operations are also used for all SUU scenarios except 2035 Internal Regional Airports.

Table 39 SUU 2035 Internal Regional Airports Average Daily Landing & Takeoff Cycles

Category	Aircraft	Day	Evening	Night
	C-141A	0.9	0.0	0.0
	C-5A	24.4	6.1	3.7
	KC-10A	33.4	5.7	3.4
	KC-135R	5.7	0.9	0.2
	T-38A	0.9	0.0	0.0
	CRJ-700	26.0	2.2	0.7
Total		91.1	14.8	8.0

Appendix B Aircraft Noise Terminology

To assist reviewers in interpreting the complex noise terminology used in evaluating airport noise, we present below an introduction to relevant fundamentals of acoustics and noise terminology.

B.1 Introduction to Acoustics and Aircraft Noise Terminology

Five acoustical descriptors of noise are introduced here in increasing degree of complexity:

- Decibel, dB
- A-weighted decibel
- Maximum Sound Level, L_{max}
- Time Above, TA
- Sound Exposure Level, SEL
- Equivalent Sound Level, Leq
- Community Noise Equivalent Level, CNEL

These descriptors form the basis for the majority of noise analysis conducted at most airports throughout California.

B.1.1 Decibel, dB

All sounds come from a sound source -- a musical instrument, a voice speaking, an airplane passing overhead. It takes energy to produce sound. The sound energy produced by any sound source is transmitted through the air in sound waves -- tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear.

Our ears are sensitive to a wide range of sound pressures. Although the loudest sounds that we hear without pain have about one million times more energy than the quietest sounds we hear, our ears are incapable of detecting small differences in these pressures. Thus, to better match how we hear this sound energy, we compress the total range of sound pressures to a more meaningful range by introducing the concept of sound pressure level.

Sound pressure levels are measured in decibels (or dB). Decibels are logarithmic quantities reflecting the ratio of the two pressures, the numerator being the pressure of the sound source of interest, and the denominator being a reference pressure (the quietest sound we can hear).

The logarithmic conversion of sound pressure to sound pressure *level* (SPL) means that the quietest sound that we can hear (the reference pressure) has a sound pressure level of about 0 dB, while the loudest sounds that we hear without pain have sound pressure levels of about 120 dB. Most sounds in our day-to-day environment have sound pressure levels on the order of 30 to 100 dB.

Because decibels are logarithmic quantities, combining decibels is unlike common arithmetic. For example, if two sound sources each produce 100 dB operating individually and they are then operated together, they produce 103 dB -- not the 200 decibels we might expect. Four equal sources operating simultaneously produce another three decibels of noise, resulting in a total sound pressure level of 106 dB. For every doubling of the number of equal sources, the sound pressure level goes up another three decibels. A tenfold increase in the number of sources makes the sound pressure level go up 10 dB. A hundredfold increase makes the level go up 20 dB, and it takes a thousand equal sources to increase the level 30 dB.

If one noise source is much louder than another, the two sources operating together will produce virtually the same sound pressure level (and sound to our ears) that the louder source would produce alone. For example, a 100 dB source plus an 80 dB source produce approximately 100 dB of noise when operating together (actually, 100.04 dB). The louder source "masks" the quieter one. But if the quieter source gets louder, it will have an increasing effect on the total sound pressure level such that, when the two sources are equal, as described above, they produce a level three decibels above the sound of either one by itself.

Conveniently, people also hear in a logarithmic fashion. Two useful rules of thumb to remember when comparing sound levels are: (1) a 6 to 10 dB increase in the sound pressure level is perceived by individuals as being a doubling of loudness, and (2) changes in sound pressure level of less than about three decibels are not readily detectable outside of a laboratory environment.

B.1.2 A-Weighted dB

Another important characteristic of sound is its frequency, or "pitch." This is the rate of repetition of the sound pressure oscillations as they reach our ear. When analyzing the total noise of any source, acousticians often break the noise into frequency components (or bands) to determine how much is low-frequency noise, how much is middle-frequency noise, and how much is high-frequency noise. This breakdown is important for two reasons:

- People react differently to low-, mid-, and high-frequency noise levels. This is because our ear is better equipped to hear mid and high frequencies but is quite insensitive to lower frequencies. Thus, we find mid- and high-frequency noise to be more annoying.
- Engineering solutions to a noise problem are different for different frequency ranges. Low-frequency noise is generally harder to control.

The normal frequency range of hearing for most people extends from a low frequency of about 20 Hz to a high frequency of about 10,000 to 15,000 Hz. People respond to sound most readily when the predominant frequency is in the range of normal conversation, typically around 1,000 to 2,000 Hz. Psycho-acousticians have developed several filters which roughly match this sensitivity of our ear and thus help us to judge the relative loudness of various sounds made up of many different frequencies. The so-called A-weighting network does this best for most environmental noise sources. Sound pressure levels measured through this filter are referred to as A-weighted sound levels (measured in A-weighted decibels, or dBA).

The A-weighting network significantly discounts those parts of the total noise that occur at lower frequencies (those below about 500 Hz) and also at very high frequencies (above 10,000 Hz) where we do not hear as well. The network has very little effect, or is nearly "flat," in the middle range of frequencies between 500 and 10,000 Hz where our hearing is most sensitive. Because this network generally matches our ears' sensitivity, sounds having higher A-weighted sound levels are judged to be louder than those with lower A-weighted sound levels, a relationship which otherwise might not be true. It is for this reason that A-weighted sound levels are normally used to evaluate environmental noise sources. Figure 2 presents typical A-weighted sound levels of several common environmental sources.

Outdoor	Typical Sound Levels dB	Indoor
Concorde, Landing 1000 m. From Runway End	110	Rock Band
727-100 Takeoff 6500 m. From Start of Takeoff Roll	100	Inside Subway Train (New York)
747-200 6500 m. From Start of Takeoff Diesel Truck at 50 ft.	90	Food Blender at 3 ft.
Noisy Urban Daytime	80	Garbage Disposal at 3 ft. Shouting at 3 ft.
757-200 6500 m. From Start of Takeoff	70	Vacuum Cleaner at 10 ft.
Commercial Area Cessna 172 Landing 1000 m. From Runway End	60	Normal Speech at 3 ft.
Quiet Urban Daytime	50	Large Business Office Dishwasher Next Room
Quiet Urban Nighttime	40	Small Theater, Large Conference (Background) Library
Quiet Suburban Nighttime	30	Bedroom at night Concert Hall (Background)
Quiet Rural Nighttime	20	Broadcast & Recording Studio
	10	Threshold of Hearing
	0	

Figure 2 Common A-weighted environmental sound levels

An additional dimension to environmental noise is that A-weighted levels vary with time. For example, the sound level increases as an aircraft approaches, then falls and blends into the background as the aircraft recedes into the distance (though even the background varies as birds chirp, the wind blows, or a vehicle passes by). This is illustrated in Figure 3.

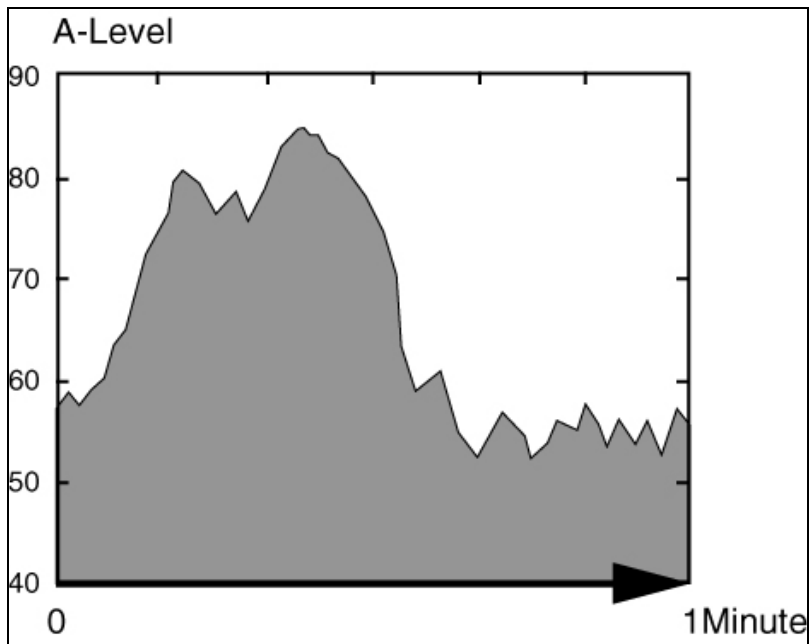


Figure 3 Variation of A-weighted sound level over time

B.1.3 Maximum sound level, L_{max} and Time Above, TA

Because of this variation, it is often convenient to describe a particular noise "event" by its maximum sound level, abbreviated as L_{max} . In Figure 3, the L_{max} is approximately 85 dBA. However, the maximum level describes only one dimension of an event; it provides no information on the cumulative noise exposure generated by a sound source. Two events with identical maximum levels may produce very different total exposures. One may be of very short duration, while the other may continue for an extended period and be judged much more annoying. The following metrics, Time Above and Sound Exposure Level, account for event duration and total exposure, respectively.

B.1.4 Time Above, TA

The Time Above is simply the amount of time that an event or set of events exceeds a given noise threshold. It is often notated as TA with a threshold value (e.g. TA 65 is the amount of time which the noise level exceeds 65 dBA). By matching a TA threshold to a particular noise effect (e.g. speech interference), the amount of time a noise effect occurs can be stated using the TA metric.

B.1.5 Sound Exposure Level, SEL

The most common measure of cumulative noise exposure for a single aircraft fly-over is the Sound Exposure Level, or SEL. SEL is an accumulation of the sound energy over the duration of a noise event. The lightly shaded area in Figure 4 illustrates the portion of the sound energy included in this dose. To account for the variety of durations that occur among different noise events, the noise dose is normalized (standardized) to a one-second duration. This normalized dose is the SEL; it is shown as the darkly shaded area in Figure 4. Mathematically, the SEL is the summation of all the noise energy compressed into one second.

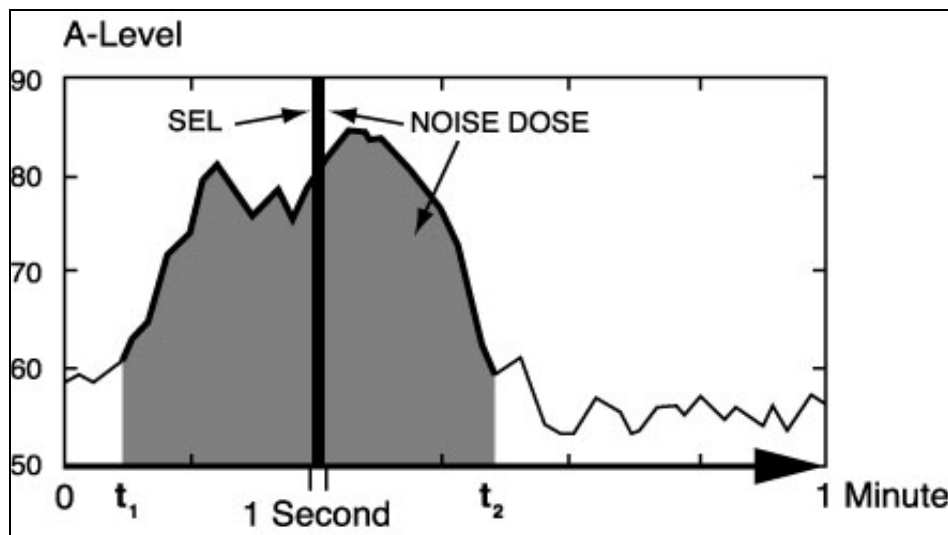


Figure 4 Graphic display of Sound Exposure Level, SEL

Note that because the SEL is normalized to one second, it will almost always be larger in magnitude than the maximum A-weighted level for the event. In fact, for most aircraft overflights, the SEL is on the order of 7 to 12 dBA higher than the L_{\max} . Also, the fact that it is a cumulative measure means that not only do louder fly-overs have higher SEL than do quieter ones, but also fly-overs with longer durations have greater SEL than do shorter ones.

With this metric, we now have a basis for comparing noise events that generally matches our impression of the sound -- the higher the SEL, the more annoying it is likely to be. In addition, SEL provides a comprehensive way to describe a noise event for use in modeling noise exposure. Computer noise models base their computations on these SELs.

B.1.6 Equivalent Sound Level, L_{eq}

The Equivalent Sound Level, abbreviated L_{eq} , is a measure of the exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest -- for example, an hour, an eight-hour school day, nighttime, or a full 24-hour day. However, because the length of the period can be different depending on the time frame of interest, the applicable period should always be identified or clearly understood when discussing the metric.

L_{eq} may be thought of as a constant sound level over the period of interest that contains as much sound energy as the actual time-varying sound level. This is illustrated in Figure 5. The equivalent level is, in a sense, the total sound energy that occurred during the time in question, but spread evenly over the time period. It is a way of assigning a single number to a time-varying sound level. Since L_{eq} includes all sound energy, it is strongly influenced by the louder events.

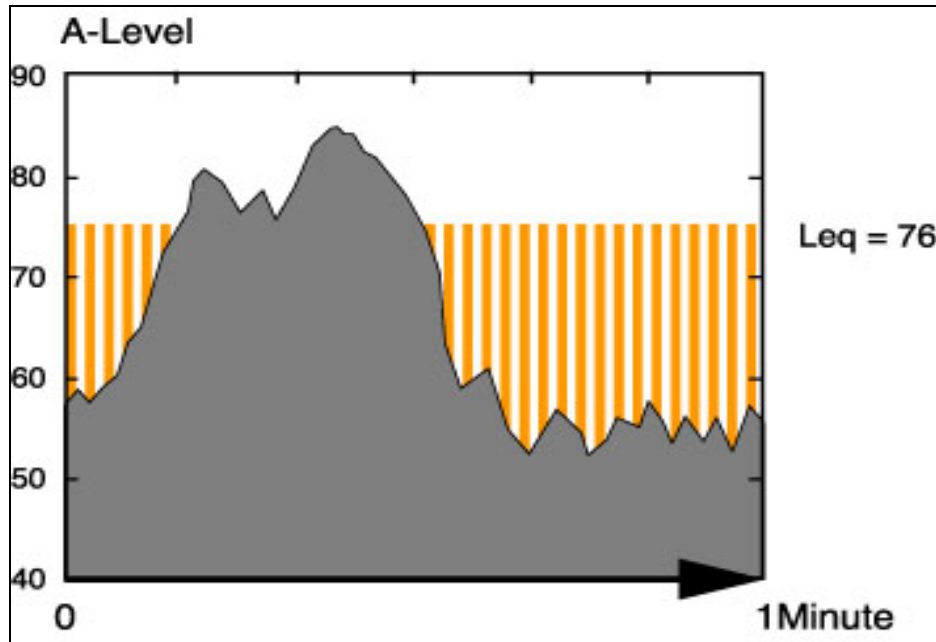


Figure 5 Graphical display of a one-minute Equivalent Sound Level, L_{eq}

As for its application to airport noise issues, L_{eq} is often presented for consecutive one-hour periods to illustrate how the hourly noise dose rises and falls throughout a 24-hour period as well as how certain hours are significantly affected by a few loud aircraft.

B.1.7 Community Noise Equivalent Level, CNEL

In the previous sections, we have been addressing noise measures that account for the moment-to-moment or short-term fluctuations in A-weighted levels as sound sources come and go affecting our overall noise environment. The Community Noise Equivalent Level (CNEL) represents a concept of noise dose as it occurs over a 24-hour period. It is the same as a 24-hour L_{eq} , with one important exception; CNEL treats evening and nighttime noise differently from daytime noise. In determining CNEL, it is assumed that the A-weighted levels occurring at night (10 p.m. to 7 a.m.) are 10 dB louder than they really are. This 10 dB penalty is applied to account for greater sensitivity to nighttime noise, and the fact that events at night are often perceived to be more intrusive because nighttime ambient noise is less than daytime ambient noise. A lesser penalty is applied to evening noise levels (7 p.m. to 10 p.m.). The evening penalty is approximately 4.77 dB and likewise accounts for the greater sensitivity to noise in the evening.

Earlier, we illustrated the A-weighted level due to an aircraft event. The example is repeated in the top frame of Figure 6. The level increases as the aircraft approaches, reaching a maximum of 85 dBA, and then decreases as the aircraft passes by. The ambient A-weighted level around 55 dBA is due to the background sounds that dominate after the aircraft passes. The shaded area reflects the noise dose that a listener receives during the one-minute period of the sample.

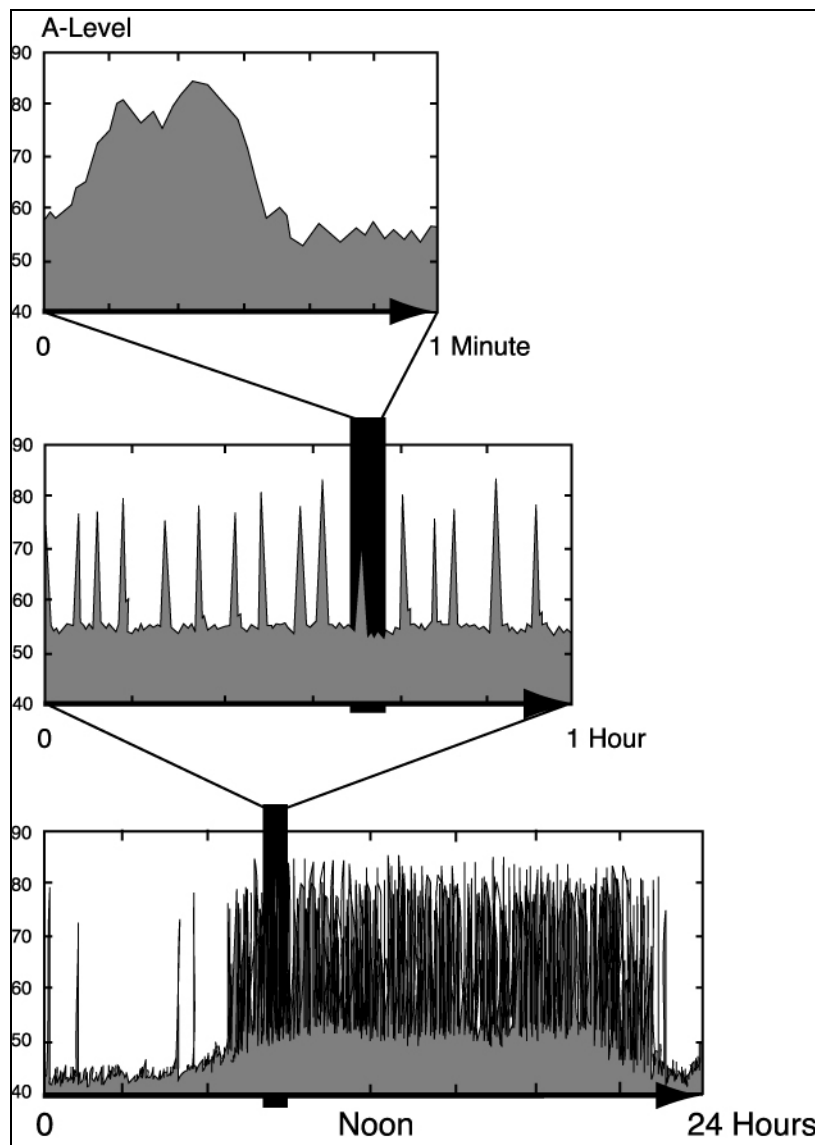


Figure 6 Sound level fluctuation and noise dose

The center frame of Figure 6 includes this one-minute interval within a full hour. Now the shaded area represents the noise dose during that hour when sixteen aircraft pass nearby, each producing a single event dose represented by an SEL. Similarly, the bottom frame includes the one-hour interval within a full 24 hours. Here the shaded area represents the noise dose over a complete day. Note that several overflights occur at night, when the background noise drops some 10 decibels, to approximately 45 dBA.

Values of CNEL are normally measured with standard monitoring equipment or are predicted with computer models. Measurements are practical for obtaining CNEL values for only relatively limited numbers of locations, and, in the absence of a permanently installed monitoring system, only for relatively short time periods. Thus, most airport noise studies utilize computer-generated estimates of CNEL, determined by accounting for all of the SEL from individual aircraft operations that comprise the total noise dose at a given location on the ground. This principle is used in all airport noise modeling.

Computed values of CNEL are usually depicted as noise contours that are lines of equal exposure around an airport (much as topographic maps have contour lines of equal elevation). The contours usually reflect long-term (annual average) operating conditions, taking into account the average flights per day, how often each runway is used throughout the year, and where over the surrounding communities the aircraft normally fly.

Ground Access Analysis Methodology and Results

July 2010

Prepared for
Metropolitan Transportation Commission
Regional Airport System Plan Analysis Phase 2

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Introduction

This technical memorandum documents the methodology and results of the ground access analysis undertaken for Phase 2 of the current Regional Airport System Plan Analysis. This work was part of the mid-point screening analysis performed to compare the Baseline Scenario with six system development scenarios defined in the study.

The regional aviation study adopted seven Goals and performance measures for each goal. The Convenient Airports goal measures the ease of airport use based on ground access distance and travel time (travel costs are also assessed, as an additional comparative metric). The ground access analysis also feeds into the evaluation of other study goals addressing the impact that each system scenario has on greenhouse gases and air pollution, by assessing the greenhouse gas and air pollution emissions produced by surface travel to and from airports.

Major outputs of the analysis, therefore, included estimation of the number of air passenger ground access and egress trips and the associated vehicle-miles of travel (VMT), travel distances, travel times and costs, and greenhouse gas (GHG) and air quality emissions (hydrocarbons and oxides of nitrogen, which combine to form smog). Underlying these calculations is the forecast distribution of air passenger trip ends in the Bay Area, as well as ground access travel by air passengers using the Bay Area airports with trip ends in the larger Northern California region.

The analysis was undertaken for the Baseline Scenario for the base year 2007 and for the Baseline and system development scenarios for the forecast demand levels in 2035. Since only those air passengers beginning or ending their air trips at the Bay Area airports contribute to ground access and egress travel, the analysis was based on the forecasts of origin and destination (O&D) passengers and excludes connecting passengers. Although airport ground access and egress travel involves trips both to and from the airports, for brevity this is referred to in the remainder of this memo as ground access travel and the trip ends are referred to as trip origins for consistency. It was assumed that the geographic distribution of trip origins and trip destinations is the same and the use of ground access and egress modes is symmetrical. Therefore the approach followed in the analysis distributed the total forecast O&D air travel to analysis zones based on the distribution of trip origins obtained from air passenger surveys conducted at the three primary Bay Area airports between 2001 and 2006, and then applied the

mode use percentages for ground access trips obtained from those surveys to determine the total amount of ground access travel by different modes.

Many air passengers travel to airports in travel parties of more than one person, which generally travel together in the same vehicle. Therefore calculations of VMT, emissions, and those aspects of travel costs that are vehicle-dependent (such as parking or taxi fares) need to be based on the number of air parties rather than the number of air passengers. The conversion of forecast air passenger trips to equivalent air party trips is discussed in more detail below.

System Development Scenarios

In addition to the Baseline Scenario, which was analyzed for both 2007 and forecast 2035 levels of Bay Area air passenger traffic, the mid-point screening analysis considered the following system development scenarios:

- Demand Redistribution
- Internal Secondary Airports
- External Airports
- High-Speed Rail
- New Air Traffic Control Technologies
- Demand Management

The ground access analysis was performed for the first four of these scenarios for forecast 2035 levels of air passenger traffic. The New Air Traffic Control (ATC) Technologies Scenario does not change the number or distribution of ground access trips from the Baseline Scenario, but reduces aircraft delays through improvements in runway capacity. The Demand Management Scenario reduces aircraft delays at San Francisco International Airport (SFO) through four effects: increasing average aircraft size for some operations, shifting flights from peak to off-peak hours, diverting some general aviation activity from SFO to other airports, and substituting bus service for some regional airline feeder flights between SFO and some of the closer small communities. Only the fourth of these effects will impact ground access analysis, adding a small number of bus trips. However, the overall effect of this on the number of ground access trips and the associated impacts is very small.

The Demand Redistribution Scenario shifts air trips between the three primary Bay Area airports, with associated changes in the ground access travel. The Internal Secondary Airports

and External Airports scenarios reflect a shift in air trips from the three primary Bay Area airports to other airports (within the region in one case and outside the region in the other), with associated changes in ground access travel.

The High-Speed Rail Scenario involves diversion of air travel to the planned California high-speed rail (HSR) system. While this reduces the number of ground access trips to the Bay Area airports, these trips become ground access travel to the HSR stations and are included in the analysis.

Analysis Zones

For ground access travel to airports and high-speed rail stations from trip origins within the nine-county Bay Area, the analysis was performed using the Metropolitan Transportation Commission (MTC) system of 1,454 travel analysis zones (TAZs). This was done partly to obtain adequate resolution of travel distances, times and costs, and partly because highway and transit network distances, travel times and costs were readily available at the TAZ level from MTC regional travel demand modeling, as discussed further below. Ground access travel from trip origins outside the nine-county Bay Area was analyzed using the system of External Travel Analysis Zones shown in Table 1. The assignment of estimated 2007 and forecast 2035 levels of regional O&D air travel to TAZs and external zones is described in a separate technical memorandum titled *Forecast Demand Allocation Methodology*.¹

Market Segmentation

The assignment of estimated 2007 and forecast future levels of regional O&D air travel to TAZs and external zones developed separate assignments for domestic and international trips, each divided into the following four market segments:

- Resident trips from home origins
- Resident trips from non-home origins
- Visitor trips from home origins
- Visitor trips from non-home origins.

¹ Aviation System Consulting, LLC, *Forecast Demand Allocation Methodology*, Prepared for the Metropolitan Transportation Commission, Regional Airport System Plan Analysis Phase 2, Berkeley, California, June 2010.

Table 1. External Travel Analysis Zones

Zone	Name	Counties
111	Lake County	
112	Mendocino County	
113	Merced County	
114	Monterey County	
115	Sacramento County	
116	San Benito County	
117	San Joaquin County	
118	Santa Cruz County	
119	Stanislaus County	
120	Yolo County	
131	Northern California	Butte, Colusa, Del Norte, Glenn, Humboldt, Lassen, Modoc, Plumas, Shasta, Sutter, Tehama, Trinity, Yuba
132	Sierra	Alpine, Amador, Calaveras, El Dorado, Inyo, Mariposa, Mono, Nevada, Placer, Sierra, Tuolumne
133	Central Valley	Fresno, Kern, Kings, Madera, Tulare
134	Central Coast	San Luis Obispo, Santa Barbara
135	Southern California	Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura

The ground access analysis was based on the projected number of annual air passenger trip ends from each analysis zone for each of the eight market segments. The number of trips in a given market segment from each analysis zone was divided among the three Bay Area airports in the Baseline Scenario according to the 2006 airport shares of trips from that zone determined from the most recent air passenger surveys for the three airports. As described in the *Forecast Demand Allocation Methodology* technical memorandum, the geographic distribution of trip origins for air passengers using Oakland International Airport (OAK) and SFO was obtained from the MTC 2006 Air Passenger Survey, while that for air passengers using Mineta San José International Airport (SJC) was obtained from the MTC 2001/2002 Air Passenger Survey. In each case the number of air passenger trip origins from each analysis zone and market segment was factored up to give the total O&D passenger traffic in 2006 at each airport.

Because the airport shares of trips in a given market segment vary widely from TAZ to TAZ, due to the limited number of survey responses in a given zone (many TAZs having no

responses at all), the airport shares were computed for a system of larger zones based on the 34 MTC superdistricts and the external zones described above. The airport shares for each superdistrict were then applied to each TAZ within that superdistrict.

Adjustments to this process were required in the case of the Demand Redistribution, Internal Secondary Airports and High-Speed Rail scenarios in order to calculate the changes in market share from each analysis zone as a result of the diversion of air passengers between the three primary Bay Area airports or from the primary airports to the secondary airports or high-speed rail. These adjustments are discussed in the *Forecast Demand Allocation Methodology* technical memorandum.

Air Party Size and Access Mode Use

In order to calculate the number of ground access vehicle trips by mode from each analysis zone, it was necessary to convert the number of air passenger trip origins to air party (strictly ground access travel party) trips. This was done by applying an average air party size for each market segment to the number of air passenger trip origins. The average air party sizes were calculated from the air passenger survey data on the basis of air parties with less than 10 air passengers. Air parties with 10 or more air passengers were calculated separately by applying the percent of air passengers in large air parties and the average large air party size to the total number of passengers in each analysis zone. Since there were only a few such large air parties in the air passenger survey data, it was felt that the geographic distribution of these trip origins were simply a result of the survey sample size and it was more reasonable to assume that large air parties could originate from any analysis zone in proportion to the total air passenger trip ends in that zone. Separate percentages of passengers in large air parties and the average large air party size were determined for domestic and international trips, but the air passenger survey data did not support a breakdown by other market segments.

The air parties from each analysis zone were then assigned to the following ground access modes based on the observed mode use in the air passenger surveys for each airport:

- Private vehicle – drop-off
- Private vehicle – parked for the air trip duration
- Rental car
- Transit

- Scheduled airport bus
- Shared-ride door-to-door van
- Taxi
- Limousine
- Hotel/motel courtesy shuttle
- Charter bus or van

The transit mode included all regional rail services as well as local bus service. Scheduled airport bus mode refers to privately operated bus services on a fixed route and schedule, such as Marin Airporter or Sonoma County Airport Express.

Separate ground access mode use percentages were calculated for each market segment and each airport for the following regional sub-areas:

- Peninsula (San Francisco and San Mateo Counties)
- South Bay (Santa Clara County)
- East Bay (Alameda and Contra Costa Counties)
- North Bay (Marin, Napa, Sonoma and Solano Counties)
- External zones.

The access mode use for each sub-region was applied to all the analysis zones within the region, under the assumption that differences in mode use between zones within a sub-region observed in the air passenger survey data are largely a result of survey sample size limitations. While there is likely to be some variation in mode use within a sub-region due to differences in access to fixed route modes and distance from the airports, the only way to account for this would be to develop and apply a mode choice model, which was beyond the scope of the study.

In the case of SJC, the East Bay and North Bay sub-regions were combined and the External sub-region only applied to the external zones to the south of the Bay Area, reflecting the limited number of air passenger trips from the North Bay or external zones to the north or east of the region in the air passenger survey data.

Private vehicle parked for the duration of the air trip was not considered a valid access mode for visitor trips, since the access trip to a Bay Area airport by visitors to the region occurs at the end of their visit and they would have no reason to park a vehicle at the airport during the

visit. However, all other access modes were considered valid modes for both residents and visitors, based on the mode use observed in the air passenger surveys.

The air passenger survey data sample size did not allow an explicit tabulation of ground access mode shares for each market segment and each regional sub-area. Tabulations were prepared of access mode use by market segment and by regional sub-area, as shown in Attachment A, and then a tabulation of access mode use by market segment for each regional sub-area was derived by a process of iterative adjustments until the resulting shares by market segment and regional sub-area agreed with the survey data.

Due to the limited number of such trips in the survey data, the same mode use by large air parties (10 or more air passengers) was assumed for both domestic and international trips.

Internal Secondary Airports

The access mode use to the internal secondary airports is likely to be rather different from that to the primary airports for a variety of reasons. These airports are only likely to have air service to major West Coast destinations, which will affect air party characteristics such as travel party size and trip duration, the trip origins are likely to be much closer to the airports on average, any transit service is likely to be very limited, and there is unlikely to be enough demand to support scheduled airport bus or shared-ride or charter van service. Because of the proximity of trip origins to the airport, there is not likely to be any rental car use by residents, since taxi would be cheaper, or use of hotel courtesy shuttles by residents or visitors with home trip origins.

Therefore the assumed access mode use was based on the observed access mode use at OAK in the 2006 MTC Air Passenger Survey for trips to West Coast destinations with trip origins in the two closest superdistricts, superdistrict 17 (Hayward and San Leandro) and 18 (Oakland and Alameda). This gave the access mode use shown in Table 2.

Access to High-Speed Rail Stations

The ridership forecasts for the planned California high-speed rail system include projections of station access modes based on the mode choice model used to estimate HSR ridership, which includes a station access mode sub-model.

Table 2. Assumed Ground Access Mode Use at Internal Secondary Airports

Ground Access Mode	Resident Trips		Visitor Trips	
	Home Origin	Other Origin	Home Origin	Other Origin
Private vehicle – drop off	58.8%	40.8%	85.3%	35.0%
Private vehicle – parked for trip	32.0%	57.1%		
Rental car			12.7%	38.3%
Taxi	7.8%	2.0%	1.0%	10.9%
Limousine	1.3%	0.0%	1.0%	1.6%
Hotel/motel courtesy shuttle				14.2%
Total	100.0%	100.0%	100.0%	100.0%

The station access model considered the following modes:

- Drive and drop-off
- Drive and park
- Rental car
- Taxi
- Transit
- Other

The HSR ridership forecasts gave the number of station access trips by mode that combined both inter-regional and intra-regional trips (those riders making high-speed rail trips entirely within the Bay Area). Since these two categories of trip are likely to have different access mode use, it was necessary to adjust the projected station access trips to exclude the intra-regional trips. Although the number of intra-regional boardings at each station was given, it was necessary to assume the access mode use for these trips. Except for the Gilroy station, where the intra-regional trips accounted for about 36 percent of all boardings, the share of boardings attributed to intra-regional trips was less than 10 percent, so any error in these assumptions would have a fairly small effect on the access mode use for inter-regional trips. It was further assumed that the “other” inter-regional access trips were divided equally between limousine and shared-ride van. This gave the access mode use shown in Table 3.

Table 3. Station Access Mode Use for High-Speed Rail Travel

Station Access Mode	High-Speed Rail Station				
	San Francisco	Millbrae	Redwood City	San José	Gilroy
Private vehicle – drop off	27.3%	34.5%	44.6%	32.1%	71.3%
Private vehicle – parked for trip	23.0%	29.1%	36.5%	27.8%	23.1%
Rental car	8.4%	9.6%	9.7%	8.8%	2.0%
Transit	19.7%	12.9%	2.2%	15.9%	1.0%
Shared-ride door-to-door van	7.6%	4.2%	0.9%	5.1%	0.2%
Taxi	6.4%	5.5%	5.1%	5.1%	2.2%
Limousine	7.6%	4.2%	0.9%	5.1%	0.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

The HSR forecasts of station boardings by access mode did not distinguish between the various market sectors, so the mode use shown in Table 3 was applied to all trips diverted to each station.

Travel Distances, Times and Costs

Highway distances and highway and transit travel times and costs for 2007 and 2035 were obtained from MTC highway and transit TAZ to TAZ network skim files from the regional travel demand model for the appropriate year. MTC staff had not run the travel demand model for 2007 conditions, so the travel times and costs from a run for 2006 conditions were used for 2007, with costs adjusted to 2007 dollars using the Bay Area consumer price index (CPI) for retail goods. A further adjustment was made for the increase in tolls on the state-owned Bay bridges that occurred between 2006 and 2007. This increased tolls by a dollar, which significantly exceeded the change in the CPI.

Highway travel times and costs

The MTC highway network travel cost data includes private vehicle operating costs as well as bridge tolls. No adjustment was made to bridge tolls for air parties large enough to qualify as a car pool during hours when car pools would be charged no toll or a reduced toll.

Accounting for the proportion of air party trips from a given analysis zone that would qualify as a car pool was considered to be beyond the level of detail that could reasonably be included in the analysis.

The MTC highway network data for 2006 and 2035 provides times and costs for two traffic conditions: AM peak and free-flow. MTC staff also provided data from an analysis that was performed for the year 2000 that divided the day into four periods (AM peak, midday, PM peak, and evening) that was prepared by MTC for a special study. Because there are significant differences between the travel times for the AM and PM peak for many TAZs, due to directional effects, and travel conditions at other times of day are often not free-flow, the 2000 data was used to develop weighted average travel times for 2006 and 2035, as follows:

1. Estimate the PM peak times for 2006 and 2035 by applying the ratio of the 2000 PM to AM peak times to the forecast AM peak times.
2. Estimate the midday and evening times for 2006 and 2035 by applying the ratio of the 2000 midday or evening to free-flow times to the forecast free-flow times.
3. Use the free-flow travel times for the remainder of the day (night and early morning).
4. Calculate the weighted travel time from each TAZ to an airport by weighting the times for each period by the percent of total passengers arriving at the airport terminal during the period, from the air passenger survey data. The peak period times were adjusted by 30 minutes to allow for the fact that a traveler arriving at the airport a few minutes into a period spent most of the access trip traveling in the previous period, giving the times and travel percentages for each period shown in Table 4.

In the case of the Internal Secondary Airports Scenario, the highway travel times and costs to each secondary airport used the weights for SFO, since this airport accounted for the majority of air passenger trips in the region. In the case of the High-Speed Rail Scenario, the highway travel times and costs to the HSR stations used the weights for SFO for trips to the San Francisco, Millbrae and Redwood City stations and the weights for SJC for trips to the San José and Gilroy stations.

Table 4. Weighting Factors for Highway Travel Times

Time Period	Arrival Time at Airport	Percent of Air Parties		
		OAK	SFO	SJC
Early AM	Midnight – 6:30 am	3.5%	5.6%	15.4%
AM peak	6:31 am – 10:30 am	16.6%	27.6%	31.3%
Midday	10:35 am – 3:30 pm	44.4%	42.1%	31.0%
PM peak	3:31 pm – 7:30 pm	29.5%	19.7%	16.4%
Evening	7:31 pm – midnight	6.0%	5.0%	5.9%

For all scenarios, the free-flow travel distance was used for calculating VMT. While the average distance driven may change by time of day, due to drivers taking different routes to avoid congestion, this was not considered to have a material impact on the results and therefore was not analyzed.

Since the external zones are not part of the nine-county Bay Area, their highway network is not included in the MTC highway network data used to determine travel times and distances in the analysis. Therefore travel times and distances from each zone to the three primary Bay Area airports, and other Bay Area airports or planned high-speed rail stations where needed, were obtained from the online trip-planning tool Mapquest by selecting a representative city or town within each of the external zones as the trip origin. No consideration was given to changes in travel time by time of day. Highway travel costs were estimated from the driving distance using the average vehicle operating cost assumed for the MTC Transportation 2035 Plan for the San Francisco Bay Area.² The vehicle operating costs were converted from 1990 dollars to 2007 dollars using the Bay Area retail CPI.

Parking Costs

Average parking costs for air parties parking for the trip duration were estimated from the airport parking rates for 2007 and the average trip duration determined from the air passenger surveys. Separate average costs were calculated for each airport and the four resident market segments (domestic and international trips from home and other origins), as shown in Table 5.

There was insufficient survey data to obtain reliable estimates of the average trip duration for international trips for market segments other than resident trips from home origins at SFO. Therefore it was assumed that all international trips had the same average duration.

Table 5. Average Parking Costs (2007 \$)

Airport	Domestic Trips		International Trips	
	Home Origins	Other Origins	Home Origins	Other Origins
OAK	57.00	47.00	83.00	69.00
SFO	67.00	50.00	98.00	73.00
SJC	66.00	57.00	97.00	83.00

The average daily parking rate at each airport considered the distribution of air party trip durations and the different use of the various parking facilities (which have different daily rates) with increasing trip duration, as determined from the air passenger surveys. This gave a generally decreasing average daily rate with increasing trip duration as a higher proportion of air parties with longer trip durations used the less expensive parking facilities. The same average daily rate for a given trip duration was applied to all market segments, as there was insufficient survey data to calculate separate average daily rates for a given trip duration for each market segment. The average parking cost for each market segment was then rounded to the nearest dollar.

Transit travel times and costs

The MTC transit network data provides travel times and costs for two access modes to transit, auto (private vehicle) access and walk access, and two time periods, AM peak and off-peak. The auto access mode is only calculated for the AM peak and accounts for the fact that someone using private vehicles to access transit has more options and most likely boards the transit system for the first time at a different location from someone walking to transit. This is particularly true for people using BART or one of the other rail systems. Separate travel times are given for walking, waiting, in-vehicle time, and (where relevant) auto access time. Transit costs include private vehicle operating costs for auto access where relevant.

² Metropolitan Transportation Commission, *Travel Forecasts Data Summary: Transportation 2035 Plan for the San*

However, different times and costs for AM peak auto access and walk access are not given for all TAZ pairs. For those TAZ pairs where auto access does not provide a travel time advantage over walk access, the auto access and walk access times and costs are the same. Also, the transit network data does not distinguish between the different transit services, particularly between bus and rail, but simply assumes that each traveler selects the best route through the entire transit system.

The transit times and costs used in the ground access analysis were therefore based on the AM peak auto access times and costs (which in many cases were the same as the walk access times and costs), and not adjusted for any changes at different times of day. Transit schedules do not vary that much over the day (except for late evening hours), particularly for BART and light rail services, and airport travelers using rail transit are likely to have someone drop them off at a BART or light rail station (or park nearby), rather than walk with their baggage to a local bus line to get to the rail station. The travel times used in the analysis combined walking, waiting, in-vehicle, and (where relevant) auto access times without any weighting for the different trip components. While travel demand modeling typically considers time walking and waiting as having a higher perceived disutility per unit time than in-vehicle time, the total travel time to the airport is given by the sum of the unweighted times.

Distance-based relationships were estimated for transit access trips to SFO using the 2006 travel times and costs (in 2007 dollars). This gave the following relationships:

$$\text{Travel time} = 35.5 + 1.785 * \text{Distance}$$

$$\text{Travel cost} = 3.67 + 0.1354 * \text{Distance}$$

for travel times in minutes, costs in dollars and distances in miles. These relationships were used to calculate transit times and costs from external zones.

Other Public Modes

Travel time and cost data for other public modes (taxi, limousine, scheduled airport bus, and shared-ride van) for access from each TAZ to the three primary Bay Area airports in 2001 had been assembled in the course of an earlier project.³ Fares were updated to 2007 dollars using

Francisco Bay Area, Oakland, California, December 2008, Table B.1.

³ Xiao-Yun Lu, Geoffrey D. Gosling, *et al.*, *A Combined Quantitative and Qualitative Approach to Planning for Improved Intermodal Connectivity at California Airports*, California PATH Research Report UCB-ITS-PRR-2009-27, University of California, Berkeley, April 2009.

the Bay Area retail CPI, but it was assumed that fares had not changed in real terms. Travel times for taxi, limousine, and shared-ride van were based on the highway travel times discussed above. Travel times for scheduled airport bus service assumed that there had been no change in bus schedules, run times, or bus stop access times since 2001. Shared-ride van fares were based on the fares for one-person travel parties with no allowance for any discounts for multi-person parties. The majority of share-ride van users have trip origins at hotels and many operators do not offer multi-person discounts for trips from hotel origins. The ground access analysis was not performed at a level of detail that would have allowed adjustments for different air party sizes or to distinguish between hotel origins and other origin types.

In the course of the earlier project, distance-based relationships for taxi and limousine fares had been developed to estimate fares from TAZs for which no fare data was available. These relationships were adjusted to 2007 dollars and used to estimate taxi and limousine fares from external zones or from TAZs to internal secondary airports or HSR stations.

Scheduled airport bus services were available in 2007 to SFO and SJC from Monterey and Santa Cruz Counties. An analysis of the schedules, run times and fares gave an average headway of 90 minutes, a run time of 10 minutes above the highway travel time, and a fare that was approximately 40 cents per mile. These relationships were used to estimate travel times and costs for scheduled airport bus service from those external zones for which no actual service data was available. The travel times were assumed to include an average wait time (schedule delay) of half the headway, consistent with the assumptions for transit service. However, no allowance was made for access time or cost to the scheduled airport bus stops, since the travel time estimates for the other modes from external zones assumed that all trips from the zone began at the reference point in the representative city.

The shared-ride van fares from external zones were assumed to be the same as limousine fares, since it was assumed that the two modes would essentially be the same, given the relatively low level of demand from external zones. However, in the case of shared-ride van service to HSR stations, a distance-based relationship was estimated from the shared-ride van fares to SFO, giving the following relationship:

$$\text{Shared-ride van fare} = 22.16 + 0.632 * \text{Distance}$$

for costs in dollars and distances in miles.

Vehicle-Miles of Travel

In general VMT was simply calculated by the number of vehicle trips from each origin zone to each airport, with appropriate adjustments for the number of air parties per vehicle for shared-ride modes and additional travel involved in drop-off or pick-up trips. For air parties dropped off by private vehicle, the VMT was doubled to account for the return trip. For air parties using taxi the access distance was increased by 10 percent to allow for some one-way travel without fares (deadheading). In the case of air parties using limousine it was assumed that all vehicles made an empty trip one way, so VMT was doubled. This may be somewhat overstated, since some limousine operators may be able to schedule a revenue trip in both directions. However, it is unlikely that the second trip would be to the same general area as the first trip origin, so this would involve some deadheading anyway. Also, limousine operators generally cover a fairly wide service area, so there would be some deadhead travel involved in picking up the first party.

It was assumed that hotel/motel courtesy shuttles would carry three air parties on average, while shared-ride door-to-door vans would carry two. No deadheading was assumed for these modes or for charter bus or van, since in general these services carry passengers in both directions and compensate for variations in demand through changing passenger loads. Charter van service is commonly provided by the same operators that provide shared-ride van service, and so they can avoid deadheading by reassigning vehicles between charter and shared-ride service as needed. This is not in general true for charter bus service, but this a fairly small proportion of total charter bus and van use.

No VMT was assigned to air parties using transit or scheduled airport bus because these services were assumed to operate anyway whether or not air passengers rode them.

Greenhouse Gas and Air Quality Emissions

Emission rates per vehicle-mile for greenhouse gases, expressed as carbon dioxide (CO₂), as well as hydrocarbons (HC) and oxides of nitrogen (NO_x) were provided by MTC staff, and are shown in Table 6. These rates were determined using the California Air Resources Board Emission Factors (EMFAC) model for the Bay Area vehicle fleet. This weighted the different vehicle classes in the EMFAC model to give a composite value for the Bay Area vehicle fleet, which was assumed to correspond to the vehicle fleet used for airport access travel. Since the

majority of airport access vehicle trips are by private vehicles, any differences in the fleet composition are likely to have a fairly small impact on emission rates. While airport access travel may involve a higher proportion of taxis, limousines, and shuttle vans than the Bay Area vehicle fleet in general, efforts by airports to promote the use of low-emission vehicles by commercial operators using the airport will tend to offset this effect.

Table 6. Fleetwide Average Vehicle Emission Rates
(grams per mile)

	2007	2035
Hydrocarbon (HC)	0.3438	0.0659
Oxides of Nitrogen (NO _x)	0.4412	0.0504
Carbon Dioxide (CO ₂)	481.95	320.22

The emission rates show a dramatic reduction in HC and NO_x per vehicle mile from 2007 to 2035, with a much less significant reduction in CO₂ emission rates. The CO₂ emission rates for 2035 assume the most stringent Pavley Phase 2 CO₂ emission standards for California, consistent with the assumptions used in MTC's latest Regional Transportation Plan environmental impact report..

The emission rates were applied to the annual VMT calculated for each scenario and converted into metric tons per day.

Access Trips to High-Speed Rail Stations

In order to calculate the ground access travel to HSR stations by passengers diverted from air travel, it was necessary to estimate the trips from each analysis zone that were diverted to HSR and allocate these trips to an HSR station. The *Forecast Demand Allocation Methodology* technical memorandum describes the process by which this was done. In summary, the number of passengers diverted to HSR from each analysis zone was assigned to the closest HSR station, based on the MTC highway network distance for free-flow conditions in 2000.

The number of diverted passengers from a given analysis zone in each market segment was converted to air parties using the average air party size for that segment and then the number

of trips for each station access mode calculated from the access mode use percentages described above in the section on Air Party Size and Access Mode Use.

Travel Distances, Times and Costs

Highway distances, travel times, and costs, and transit travel times and costs from each analysis zone to the relevant TAZ for the nearest HSR station were determined from the MTC highway and transit network data in the same way as for the airports.

Access costs for other modes from each analysis zone were estimated using the cost to distance relationships described above.

VMT and emissions were then calculated in the same way as for airports.

Ground Access Analysis Model

In order to apply the extensive calculations involved in the ground access analysis in a consistent way, a spreadsheet model was created in Microsoft Excel that comprised a separate Excel workbook for each scenario. In the case of the Internal Secondary Airports and HSR scenarios, two separate models were developed for each scenario. The first model calculated the number of undiverted trips at each of the three primary airports and their associated ground access performance measures. The second model calculated the number of trips diverted to each secondary airport or HSR station from each of the three primary airports and the associated ground access performance measures of the diverted trips.

Since the catchment areas of each secondary airport or HSR station did not overlap, the ground access performance measures for trips diverted from each airport to a given secondary airport or HSR station from each TAZ or external zone could be identified and then summed across the three primary airports to give the ground access performance measures for each secondary airport or HSR station (although the results presented in this technical memorandum are not shown by station).

The details of the Excel model structure are described in Attachment B.

External Airport Scenario

In the External Airports Scenario, a proportion of the air passenger trips from the external zones are diverted to three airports in the external zones, reducing the total number of air passenger trips to the Bay Area primary airports. No account is taken in the ground access

performance measures of the ground access travel by these diverted trips, since this occurs entirely outside the region. While air passenger vehicle trips to the External airports would still produce greenhouse gases and other air quality emissions, there is still a net environmental benefit to the larger Northern California region due to the shorter trip lengths from these diverted trips.

Ground Access Analysis Results

The ground access performance measures for each airport and the region as a whole for the 2007 Baseline Scenario are shown in Attachment C. The corresponding performance measures for each of the 2035 scenarios under the Base Case forecast are shown in Attachment D. The comparative ground access performance measures for the Baseline Scenario for 2007 and 2035 are summarized in Table 7.

Table 7. Baseline Scenario Ground Access Performance Measures

	2007	2035	Percent Change
Total annual O&D passengers	50,192,688	81,179,487	61.7%
Total passenger access time (hr)	40,510,766	67,695,658	67.1%
Total passenger access distance (000 mi)	1,464,624	2,418,000	65.1%
Total access cost (\$000)	962,105	1,672,443	73.8%
VMT (000)	1,243,874	2,029,387	63.2%
VMT per passenger	24.78	25.00	0.9%
Average passenger access distance (mi)	29.18	29.79	2.1%
Average passenger access time (hr)	0.807	0.834	3.3%
Average cost per passenger (\$)	19.17	20.60	7.5%
GHG (CO2) emissions (metric ton/day)	1,642	1,780	8.4%
NOx + HC emissions (metric ton/day)	2.675	0.647	(75.8%)

It can be seen that the total passenger access distance, passenger access time, passenger access cost, and vehicle-miles of travel all increased by more than the increase in total annual O&D passengers, with the average passenger access cost increasing somewhat faster than the

average access distance and time. This is largely a result of the assumed increase in real private vehicle operating costs from 2007 to 2035. VMT per passenger increases by less than the increase in average passenger access distance, due largely to changes in the share of the regional passenger traffic handled by each airport. In the Baseline Scenario the share of regional passengers using SFO increases due to the higher forecast growth in international travel, while SFO has the lowest VMT per passenger of the three airports due to the greater use of higher occupancy modes, as can be seen from the detailed results by airport in Attachments C and D. Greenhouse gas emissions increase by about 8 percent from 2007 to 2035 in spite of the assumed improvements in average emission factors, due to the increase in VMT more than offsetting the reduction in emission factors. However, the air quality emissions (HC and NO_x) decrease by over 75 percent due to the large assumed reduction in average vehicle emission factors.

The differences in ground access performance in 2035 between the four system development scenarios with differences in ground access travel are shown in Table 8, expressed as a percentage change from the Baseline Scenario.

Table 8. Comparative Scenario Ground Access Performance Measures for 2035

	Percent Change from Baseline Scenario			
	Demand Redistrib- ution	Internal Secondary Airports	External Airports	High- Speed Rail
Total annual passengers	-	-	(2.1%)	-
Total passenger access time (hr)	(0.8%)	(3.5%)	(3.8%)	(1.8%)
Total passenger access distance (000 mi)	(0.2%)	(4.1%)	(5.7%)	(2.6%)
Total access cost (\$000)	0.0%	(2.5%)	(4.7%)	(0.4%)
VMT (000)	1.0%	(3.6%)	(6.2%)	(3.0%)
VMT per passenger	1.0%	(3.6%)	(4.2%)	(3.0%)
Average passenger access distance (mi)	(0.2%)	(4.1%)	(3.7%)	(2.6%)
Average passenger access time (hr)	(0.8%)	(3.5%)	(1.7%)	(1.8%)
Average cost per passenger (\$)	0.0%	(2.5%)	(2.7%)	(0.4%)
GHG (CO ₂) emissions (metric ton/day)	1.0%	(3.6%)	(6.2%)	(3.0%)
NO _x + HC emissions (metric ton/day)	1.0%	(3.6%)	(6.2%)	(3.0%)

The Demand Redistribution Scenario shows a 1 percent increase in VMT and associated greenhouse gas and air quality emissions over the Baseline Scenario, no change in the average cost per passenger, and the least reduction in average passenger access distance and time of the four scenarios. The apparently counter-intuitive result in which the average passenger access distance goes down slightly while VMT increases by about 1 percent results from the shift of domestic traffic from SFO to OAK and SJC. It can be seen from the results for each airport in Attachment D that SFO generates somewhat fewer VMT per passenger than the other two airports (particularly OAK), due to the greater use of higher occupancy modes, particularly transit. Thus redistributing traffic from SFO to OAK and SJC increases VMT, although the average passenger access distances at OAK and SJC are less than at SFO (and the average passenger access distance goes down slightly at OAK compared to the Baseline Scenario), leading to a slight overall reduction in average passenger access distance for the region. As can be seen from the detailed results in Attachment D, the average VMT per passenger goes down slightly at OAK and SJC in the Demand Redistribution Scenario compared to the Baseline Scenario, but increases at SFO, largely reflecting the increase in average passenger access distance at SFO, which results in part from the increase in the proportion of international trips (as domestic trips get redistributed), which have a longer average access distance.

Not surprisingly, the External Airports Scenario shows the most improvement in all ground access performance measures compared to the Baseline Scenario, because the number of annual passengers using the Bay Area airports is reduced by about 2 percent, while the average passenger access distance is also reduced as longer access trips from the external zones are diverted to the external airports. The combined effect of reduced passenger trips and reduced average access distance reduces VMT (and the associated emissions) by about 6 percent.

Of the other two scenarios, the Internal Secondary Airports Scenario shows somewhat greater improvements from the Baseline Scenario than the High-Speed Rail Scenario in all the ground access performance measures. The Internal Secondary Airports Scenario shows the greatest reduction in average passenger access distance and average passenger access time of the four scenarios, as the passenger trips that are diverted to the secondary airports have greatly reduced access distances and times. However, the reduction in VMT (and the associated emissions) and average passenger access cost are somewhat less than the reduction in average passenger access distance due to the greater use of private vehicles in the assumed access mode

use for the secondary airports, which increases the VMT per passenger relative to the change in the average access distance.

Although the High-Speed Rail Scenario projects a much higher diversion of passengers trips from the three primary Bay Area airports than the Internal Secondary Airports Scenario, the improvement in all the ground access performance measures compared to the Baseline Scenario is somewhat less, particularly for the average passenger access time and the average cost per passenger, since the high-speed rail stations are located fairly close to two of the airports, so there is a much smaller reduction in average passenger access distance and related measures. The even smaller reduction in average passenger access time and access cost results from the mode use assumptions for access trips to the HSR stations.

Summary and Conclusions

The ground access performance calculations described in this technical memorandum have been derived from an extensive analysis of air party characteristics derived from the results of the most recent air passenger surveys at the three primary Bay Area airports. These air party characteristics have been combined with detailed transportation level of service data for airport ground access modes obtained from MTC travel demand modeling for the regional highway and transit networks and data for other public modes developed in the course of previous research.

The analysis has been performed by developing a complex model in Microsoft Excel that allowed the ground access performance measures for the various system development scenarios to be derived in a repeatable and consistent way.

The results of the analysis show that for the Baseline Scenario the growth in demand from 2007 to 2035 will result in a significant increase in VMT of about 63 percent and a more modest increase in greenhouse gases of about 8 percent due to improvements in vehicle emission rates. There will be a significant reduction in other air quality emissions of about 75 percent, also due to stringent California vehicle emission standards. Average passenger distance, access time and cost increase between 2 and 7.5 percent.

Of the four system development scenarios for which ground access performance measures were calculated for 2035, the largest improvements compared to the Baseline Scenario were given by the External Airports Scenario, due both to the reduction in total passenger demand at the Bay Area airports and the fact that the passengers diverted to external airports had

some of the longest access journeys when they used the Bay Area airports. However, these reductions in VMT were not large enough to completely offset the increase in greenhouse gas emissions in the Baseline Scenario. While they reduced the average passenger access distance for those air passengers using the Bay Area airports below the average distance in 2007, this effect was not enough to reduce the average passenger access time and cost below their levels in 2007.

Of the other three scenarios, the Internal Secondary Airports Scenario gave the largest improvement in ground access performance measures compared to the Baseline Scenario. This scenario reduced the average passenger access distance and time below the levels experienced in 2007, although this was not enough to reduce the average passenger access cost below its 2007 level.

Attachment A

Ground Access Mode Use at Primary Bay Area Airports**Ground Access Mode Use by Market Segment**

(Air Parties of Less than 10 People)

OAKLAND INTERNATIONAL AIRPORT – 2006

Ground Access Mode	Resident Trips		Visitor Trips	
	Home Origin	Other Origin	Home Origin	Other Origin
	Domestic Trips			
Private vehicle – drop off	45.7%	31.0%	67.2%	22.4%
Private vehicle – parked for trip	31.5%	36.6%	n/a	n/a
Rental car	0.7%	0.7%	14.5%	39.5%
Transit	11.7%	24.1%	12.0%	16.9%
Scheduled airport bus	1.7%		0.9%	0.4%
Shared-ride door-to-door van	2.0%	2.6%	1.7%	5.6%
Taxi	2.7%	1.0%	1.5%	7.1%
Limousine	1.2%	1.0%	0.5%	2.6%
Hotel/motel courtesy shuttle	0.2%	2.6%	0.1%	3.9%
Charter bus or van	2.6%	0.3%	1.5%	1.5%
Total	100.0%	100.0%	100.0%	100.0%
	International Trips			
Private vehicle – drop off	84.2%		90.9%	33.3%
Private vehicle – parked for trip	13.2%		n/a	n/a
Rental car			9.1%	16.7%
Transit				16.7%
Scheduled airport bus				
Shared-ride door-to-door van				16.7%
Taxi				16.7%
Limousine				
Hotel/motel courtesy shuttle				
Charter bus or van	2.6%			
Total	100.0%		100.0%	100.0%

Notes: No survey data for resident international trips from non-home origins.

n/a = not applicable

Ground Access Mode Use by Market Segment
(Air Parties of Less than 10 People)

SAN FRANCISCO INTERNATIONAL AIRPORT – 2006

Ground Access Mode	Resident Trips		Visitor Trips	
	Home Origin	Other Origin	Home Origin	Other Origin
	Domestic Trips			
Private vehicle – drop off	40.4%	26.9%	63.7%	11.8%
Private vehicle – parked for trip	21.6%	24.7%	n/a	n/a
Rental car	1.3%	1.3%	13.9%	32.1%
Transit	12.3%	19.4%	9.4%	7.4%
Scheduled airport bus	3.7%	0.9%	3.2%	0.3%
Shared-ride door-to-door van	5.0%	5.3%	2.4%	19.4%
Taxi	9.5%	7.9%	4.5%	16.6%
Limousine	3.6%	0.4%	0.9%	6.2%
Hotel/motel courtesy shuttle	0.4%	11.9%		4.8%
Charter bus or van	2.4%	1.3%	2.1%	1.4%
Total	100.0%	100.0%	100.0%	100.0%
	International Trips			
Private vehicle – drop off	52.9%	30.0%	66.4%	13.5%
Private vehicle – parked for trip	12.2%	2.5%	n/a	n/a
Rental car	1.2%		15.1%	29.6%
Transit	9.8%	10.0%	10.3%	9.0%
Scheduled airport bus	2.7%	2.5%	0.7%	0.3%
Shared-ride door-to-door van	4.4%	10.0%	1.4%	21.9%
Taxi	8.3%	2.5%	3.4%	15.1%
Limousine	5.1%	10.0%	1.4%	5.8%
Hotel/motel courtesy shuttle	0.5%	32.5%		3.9%
Charter bus or van	2.9%		1.4%	1.0%
Total	100.0%	100.0%	100.0%	100.0%

Ground Access Mode Use by Market Segment
(Air Parties of Less than 10 People)

SAN JOSE INTERNATIONAL AIRPORT– 2001/2002

Ground Access Mode	Resident Trips		Visitor Trips	
	Home Origin	Other Origin	Home Origin	Other Origin
	Domestic Trips			
Private vehicle – drop off	55.9%	37.6%	76.5%	17.0%
Private vehicle – parked for trip	28.4%	36.4%	n/a	n/a
Rental car	1.2%	8.0%	19.3%	63.6%
Transit	1.7%	4.7%	1.5%	1.3%
Scheduled airport bus	0.4%	1.3%		0.9%
Shared-ride door-to-door van	1.4%	0.3%	0.6%	0.6%
Taxi	9.4%	9.2%	1.3%	9.3%
Limousine	1.4%	0.6%	0.6%	1.0%
Hotel/motel courtesy shuttle		1.6%	0.2%	6.1%
Charter bus or van		0.3%	0.1%	0.3%
Total	100.0%	100.0%	100.0%	100.0%
	International Trips			
Private vehicle – drop off	66.0%	41.0%	85.4%	22.0%
Private vehicle – parked for trip	13.4%	20.5%	n/a	n/a
Rental car	2.0%	5.1%	8.4%	50.4%
Transit	1.9%	10.3%	1.8%	1.4%
Scheduled airport bus			0.9%	2.1%
Shared-ride door-to-door van	1.9%		0.9%	1.4%
Taxi	12.3%	17.9%	1.8%	11.3%
Limousine	2.1%		0.9%	5.7%
Hotel/motel courtesy shuttle	0.5%	5.1%		4.3%
Charter bus or van				1.4%
Total	100.0%	100.0%	100.0%	100.0%

Ground Access Mode Use by Air Parties of 10 or More Passengers
(Domestic and International Trips)

Ground Access Mode	OAK 2006	SFO 2006	SJC 2001/2002
Private vehicle – drop off	12.5%	13.5%	22.5%
Private vehicle – parked for trip		5.4%	2.5%
Rental car	25.0%	10.8%	50.0%
Transit	12.5%		2.5%
Scheduled airport bus			
Shared-ride door-to-door van			5.0%
Taxi	12.5%	5.4%	
Limousine		2.7%	7.5%
Hotel/motel courtesy shuttle			2.5%
Charter bus or van	37.5%	62.2%	7.5%
Total	100.0%	100.0%	100.0%

Ground Access Mode Use by Regional Sub-area
(Air Parties of Less than 10 People)

OAKLAND INTERNATIONAL AIRPORT – 2006

Ground Access Mode	Domestic Trips				
	Peninsula	South Bay	East Bay	North Bay	External Zones
Private vehicle – drop off	25.6%	50.5%	48.8%	32.0%	46.8%
Private vehicle – parked for trip	9.8%	18.3%	16.0%	20.5%	21.6%
Rental car	11.2%	22.0%	15.1%	26.8%	21.6%
Transit	36.4%	5.4%	9.1%	3.1%	2.2%
Scheduled airport bus				6.6%	1.4%
Shared-ride door-to-door van	7.3%	2.2%	2.2%	1.0%	
Taxi	6.2%		3.9%	1.0%	1.4%
Limousine	3.3%	1.1%	1.0%	0.6%	1.4%
Hotel/motel courtesy shuttle	0.1%		2.6%	1.2%	2.9%
Charter bus or van	0.1%	0.5%	1.3%	7.2%	0.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%
	International Trips				
	Peninsula		East Bay		Other Zones
Private vehicle – drop off	60.0%		91.7%		80.0%
Private vehicle – parked for trip	10.0%		4.2%		15.0%
Rental car					5.0%
Transit	10.0%				
Scheduled airport bus					
Shared-ride door-to-door van	10.0%				
Taxi	10.0%				
Limousine					
Hotel/motel courtesy shuttle					
Charter bus or van			4.2%		
Total	100.0%		100.0%		100.0%

Note: Other Zones combines South Bay, North Bay and External Zones for international trips.

Ground Access Mode Use by Regional Sub-area
(Air Parties of Less than 10 People)

SAN FRANCISCO INTERNATIONAL AIRPORT – 2006

Ground Access Mode	Domestic Trips				
	Peninsula	South Bay	East Bay	North Bay	External Zones
Private vehicle – drop off	25.0%	40.8%	33.3%	27.7%	31.4%
Private vehicle – parked for trip	5.7%	13.9%	11.1%	13.3%	16.6%
Rental car	13.5%	28.1%	18.6%	27.7%	31.4%
Transit	10.2%	4.1%	25.9%	1.7%	
Scheduled airport bus	0.1%	0.3%		14.2%	2.3%
Shared-ride door-to-door van	17.1%	5.8%	3.1%	1.4%	1.7%
Taxi	18.5%	2.5%	2.6%	1.2%	1.1%
Limousine	5.2%	3.5%	3.5%	1.7%	2.3%
Hotel/motel courtesy shuttle	4.1%	1.0%	0.7%	0.7%	9.1%
Charter bus or van	0.5%	0.0%	1.2%	10.4%	4.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%
	International Trips				
	Peninsula	South Bay	East Bay	North Bay	External Zones
Private vehicle – drop off	29.8%	54.2%	45.5%	40.8%	43.3%
Private vehicle – parked for trip	2.0%	11.9%	7.5%	7.0%	7.2%
Rental car	14.1%	16.4%	3.7%	12.7%	15.5%
Transit	9.1%	3.0%	27.6%	4.2%	4.1%
Scheduled airport bus				16.9%	2.1%
Shared-ride door-to-door van	19.7%	3.0%	3.0%		4.1%
Taxi	16.9%	4.0%	5.2%	1.4%	4.1%
Limousine	4.8%	6.5%	5.2%	1.4%	5.2%
Hotel/motel courtesy shuttle	3.3%	0.5%		2.8%	11.3%
Charter bus or van	0.3%	0.5%	2.2%	12.7%	3.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Ground Access Mode Use by Regional Sub-area
(Air Parties of Less than 10 People)

SAN JOSE INTERNATIONAL AIRPORT – 2001/2002

Ground Access Mode	Domestic Trips			
	Peninsula	South Bay	External (South)	Other Zones
Private vehicle – drop off	52.1%	51.3%	46.6%	47.9%
Private vehicle – parked for trip	15.8%	14.3%	24.1%	15.3%
Rental car	22.7%	17.9%	26.4%	32.0%
Transit	4.3%	1.8%	0.2%	0.9%
Scheduled airport bus	0.6%	0.5%	0.7%	0.4%
Shared-ride door-to-door van	1.2%	0.9%	1.0%	0.2%
Taxi	1.5%	10.0%		1.7%
Limousine	1.5%	1.1%	0.7%	1.0%
Hotel/motel courtesy shuttle	0.4%	2.1%	0.2%	
Charter bus or van				0.6%
Total	100.0%	100.0%	100.0%	100.0%
	International Trips			
		South Bay	External (South)	Other Zones
Private vehicle – drop off		59.9%	69.4%	65.8%
Private vehicle – parked for trip		7.1%	6.7%	11.9%
Rental car		10.6%	17.7%	14.9%
Transit		1.3%	4.7%	3.0%
Scheduled airport bus		0.8%		
Shared-ride door-to-door van		1.3%	1.6%	
Taxi		14.6%		
Limousine		2.8%		1.5%
Hotel/motel courtesy shuttle		1.3%		1.5%
Charter bus or van				1.5%
Total		100.0%	100.0%	100.0%

Notes: External (South) comprises Monterey, San Benito, and Santa Cruz Counties and Central Coast external zones.

Other Zones includes Peninsula for international trips and East Bay, North Bay and other external zones for all trips.

Attachment B

Ground Access Analysis Model Structure

The Microsoft Excel spreadsheet model to perform the ground access analysis calculations for a given scenario comprises a separate calculation worksheet for each airport, a summary worksheet presenting the ground access performance measures for each airport and the regional total, and several ancillary worksheets containing supporting data for the calculations.

Primary Airport Worksheets

The worksheets in each Excel file for each of the three primary Bay Area airports are organized in a large table with a row for each superdistrict, external zone and TAZ. The columns are organized into a series of panels as follows:

- Columns A and B Superdistrict, external zone, regional sub-area and TAZ numbers and labels
- Columns C to J Regional air passengers by superdistrict, external zone and TAZ for each market segment
- Columns L to S Air passengers from each superdistrict, external zone and TAZ allocated to the primary airport in question by market segment based on the airport share data in the ancillary worksheets, with a adjustment factors to reconcile the airport total domestic and international passengers to the forecast demand for that airport
- Columns U to AD Air parties from each superdistrict, external zone and TAZ allocated to the primary airport in question by market segment based on the average air party size for each market segment, and divided into air parties with less than 10 air passengers by market segment and larger air parties grouped by domestic and international trips

- Column AE The reference code for the relevant sub-regional area for each superdistrict, external zone and TAZ
- Columns AF to AO The number of air parties from each superdistrict, external zone and TAZ using each mode to access the primary airport in question, based on the mode use data in the ancillary worksheets for each market segment and regional sub-area
- Columns AQ to BB The resulting travel distances, travel times and costs by access mode for each external zone and TAZ
- Columns BD to BJ Calculation of the associated ground access performance measures for each external zone and TAZ, together with the regional total for each performance measure.

The adjustment factors described for Columns L to S correct for any differences in total airport passengers arising from applying the airport share data from the air passenger survey results by superdistrict and external zone to the assigned zonal demand. However, these adjustment factors also provide a means to adjust the number of air passengers from each analysis zone, and hence the number of air parties, trips by access mode, and ground access performance measures, for the changes in airport passengers under the Demand Redistribution Scenario.

Because the calculations of travel distances, travel times and costs by access mode and the ground access performance analysis is performed at the level of TAZs and external zones, no specific calculations of ground access performance are performed for superdistricts, although superdistrict totals can be obtained by summing the relevant values for the TAZs within each superdistrict.

Ancillary Worksheets

All the Excel files contain the following worksheets:

- **Shares** provides a table showing the airport shares by superdistrict and external zone for each market segment

- **ModeUse** provides a table showing the ground access mode use for each airport by market segment and regional sub-area
- **Factors** provides a table of the emission factors per vehicle-mile for 2007 and 2035
- **LOS** provides a table showing the highway, transit and other public mode levels of service (highway distance, and travel times and costs for each mode) for each airport from each TAZ
- **Park** provides a table of the average parking cost for each airport by resident market segment.

In addition, the Excel files for the Internal Secondary Airports, External Airports, and High-Speed Rail Scenarios each contain the following worksheet:

- **Diversion** provides a table showing the number of passengers diverted from each primary airport to each secondary airport, or to the external airports or HSR (depending on the scenario), as well as the associated diversion rates.

For the Internal Secondary Airports Scenario, this table shows the total number of domestic trips allocated to each of the primary airports in the Baseline Scenario from each TAZ and external zone, the TAZs or external zones within the catchment area of each secondary airport, the total number of domestic trips at each primary airport from each catchment area, and the diversion rate for the trips to each primary airport from each catchment area. This diversion rate is then assigned to the relevant TAZs or external zones and used in the primary airport calculation worksheets to calculate the number of trips from a given TAZ or external zone diverted to a secondary airport and the associated ground access performance measures.

For the External Airports Scenario, the table shows the total number of passengers diverted to the external airports from each of the primary airports as well as the diversion rate for air passengers from each external zone to each primary airport, and in the case of OAK from two of the Bay Area superdistricts.

In the case of the High-Speed Rail Scenario, the table simply shows the number of diverted and undiverted passenger trips for each primary airport and the associated diversion rate, since this rate is applied to all TAZs and external zones for that airport.

In the case of the Excel file for the ground access performance measures for trips diverted to internal secondary airports, the **LOS** worksheet for the three primary airports is replaced by a **LOS-Int** worksheet that gives the highway distances, travel times and costs from each TAZ to the relevant secondary airport. Since only some TAZs lie within the catchment area of one of the secondary airports, much of the table has zero values.

In the case of the Excel file for the ground access performance measures for trips diverted to HSR, the **LOS** worksheet for the three primary airports is replaced by a **LOS-HSR** worksheet that gives the highway distances and highway and transit travel times and costs from each TAZ to the closest HSR station.

Summary Worksheet

The summary worksheet contains a table showing the number of O&D air passengers and ground access performance measures for each primary airport, together with the regional total.

In the case of the Internal Secondary Airports Scenario, the summary worksheet for the first Excel workbook shows the number of *undiverted* air passenger trips and associated ground access performance measures for each primary airport while the summary worksheet for the second Excel workbook shows the number of *diverted* air passenger trips at each secondary airport and the associated ground access performance measures.

In the case of High-Speed Rail Scenario, the summary worksheet for the first Excel workbook is the same as for the Internal Secondary Airports Scenario while the summary worksheet for the second Excel workbook shows the number of *diverted* air passenger trips at each primary airport and the associated ground access performance measures.

In addition to the number of O&D air passengers and ground access performance measures for each primary airport, the summary worksheet for the External Airports Scenario also shows the number of air passenger trips diverted to each of the external airports.

Attachment C

Ground Access Analysis Results – 2007

Baseline Scenario – Base Case Forecast

	OAK	SFO	SJC	Total
Total annual O&D passengers	13,763,823	26,311,905	10,116,959	50,192,688
Total passenger access time (hr)	11,244,844	22,354,691	6,911,231	40,510,766
Total passenger access distance (000 mi)	394,422	793,381	276,821	1,464,624
Total access cost (\$000)	271,790	514,357	175,957	962,105
VMT (000)	382,560	602,215	259,099	1,243,874
VMT per passenger	27.79	22.89	25.61	24.78
Average passenger access distance (mi)	28.66	30.15	27.36	29.18
Average passenger access time (hr)	0.817	0.850	0.683	0.807
Average cost per passenger (\$)	19.75	19.55	17.39	19.17
GHG (CO2) emissions (metric ton/day)	505	795	342	1,642
NOx + HC emissions (metric ton/day)	0.823	1.295	0.557	2.675

Note: OAK Oakland International Airport
 SFO San Francisco International Airport
 SJC San José International Airport

Attachment D

Ground Access Analysis Results – 2035

Baseline Scenario – Base Case Forecast

	OAK	SFO	SJC	Total
Total annual O&D passengers	19,391,868	46,432,621	15,354,998	81,179,487
Total passenger access time (hr)	15,412,011	42,115,212	10,168,435	67,695,658
Total passenger access distance (000 mi)	550,476	1,462,589	404,935	2,418,000
Total access cost (\$000)	402,802	979,712	289,928	1,672,443
VTM (000)	537,266	1,112,737	379,384	2,029,387
VTM per passenger	27.71	23.96	24.71	25.00
Average passenger access distance (mi)	28.39	31.50	26.37	29.79
Average passenger access time (hr)	0.795	0.907	0.662	0.834
Average cost per passenger (\$)	20.77	21.10	18.88	20.60
GHG (CO2) emissions (metric ton/day)	471	976	333	1,780
NOx + HC emissions (metric ton/day)	0.171	0.355	0.121	0.647

Demand Redistribution Scenario – Base Case Forecast

	OAK	SFO	SJC	Total
Total annual O&D passengers	21,795,104	42,108,851	17,275,532	81,179,487
Total passenger access time (hr)	17,314,455	38,426,390	11,439,937	67,180,782
Total passenger access distance (000 mi)	617,971	1,340,317	455,532	2,413,820
Total access cost (\$000)	452,792	893,685	325,851	1,672,328
VTM (000)	602,744	1,020,868	426,666	2,050,278
VTM per passenger	27.66	24.24	24.70	25.26
Average passenger access distance (mi)	28.35	31.83	26.37	29.73
Average passenger access time (hr)	0.794	0.913	0.662	0.828
Average cost per passenger (\$)	20.77	21.22	18.86	20.60
GHG (CO2) emissions (metric ton/day)	529	896	374	1,799
NOx + HC emissions (metric ton/day)	0.192	0.325	0.136	0.653

Note: OAK Oakland International Airport
SFO San Francisco International Airport
SJC San José International Airport

Internal Secondary Airports Scenario – Base Case Forecast

	OAK	SFO	SJC	Total Primary
Total annual O&D passengers	18,018,338	45,225,205	15,298,351	78,541,894
Total passenger access time (hr)	13,712,956	39,977,618	10,059,843	63,750,417
Total passenger access distance (000 mi)	481,629	1,390,594	400,416	2,272,638
Total access cost (\$000)	364,244	944,664	287,964	1,596,872
VTM (000)	469,604	1,062,014	375,444	1,907,062
VTM per passenger	26.06	23.48	24.54	24.28
Average passenger access distance (mi)	26.73	30.75	26.17	28.94
Average passenger access time (hr)	0.761	0.884	0.658	0.812
Average cost per passenger (\$)	20.22	20.89	18.82	20.33
GHG (CO2) emissions (metric ton/day)	412	932	329	1,673
NOx + HC emissions (metric ton/day)	0.150	0.338	0.120	0.608

	Sonoma County	Concord Buchanan	Travis AFB	Total Secondary
Total annual O&D passengers	705,157	1,127,120	805,316	2,637,593
Total passenger access time (hr)	492,485	455,209	619,854	1,567,548
Total passenger access distance (000 mi)	15,386	12,407	19,028	46,820
Total access cost (\$000)	10,628	11,708	10,599	32,935
VTM (000)	16,944	14,338	18,396	49,678
VTM per passenger	24.03	12.72	22.84	18.83
Average passenger access distance (mi)	21.82	11.01	23.63	17.75
Average passenger access time (hr)	0.698	0.404	0.770	0.594
Average cost per passenger (\$)	15.07	10.39	13.16	12.49
GHG (CO2) emissions (metric ton/day)	15	13	16	44
NOx + HC emissions (metric ton/day)	0.005	0.005	0.006	0.016

	Primary	Secondary	Total
Total annual O&D passengers	78,541,894	2,637,593	81,179,487
Total passenger access time (hr)	63,750,417	1,567,548	65,317,965
Total passenger access distance (000 mi)	2,272,638	46,820	2,319,458
Total access cost (\$000)	1,596,872	32,935	1,629,807
VTM (000)	1,907,062	49,678	1,956,741
VTM per passenger	24.28	18.83	24.10
Average passenger access distance (mi)	28.94	17.75	28.57
Average passenger access time (hr)	0.812	0.594	0.805
Average cost per passenger (\$)	20.33	12.49	20.08
GHG (CO2) emissions (metric ton/day)	1,673	44	1,717
NOx + HC emissions (metric ton/day)	0.608	0.016	0.623

External Airports Scenario – Base Case Forecast

	OAK	SFO	SJC	Total Bay Area
Total annual O&D passengers	18,930,199	45,983,287	14,561,110	79,474,596
Total passenger access time (hr)	14,791,759	41,179,680	9,154,238	65,125,677
Total passenger access distance (000 mi)	516,853	1,410,624	352,782	2,280,259
Total access cost (\$000)	384,792	951,654	257,314	1,593,760
VTM (000)	501,383	1,070,047	331,608	1,903,038
VTM per passenger	26.49	23.27	22.77	23.95
Average passenger access distance (mi)	27.30	30.68	24.23	28.69
Average passenger access time (hr)	0.781	0.896	0.629	0.819
Average cost per passenger (\$)	20.33	20.70	17.67	20.05
GHG (CO2) emissions (metric ton/day)	440	939	291	1,670
NOx + HC emissions (metric ton/day)	0.160	0.341	0.106	0.606

	Trips Diverted to External Airports			
	SMF	MRY	SCK	Total
Total annual O&D passengers	611,595	996,606	96,689	1,704,891

	Bay Area	External	Total
Total annual O&D passengers	79,474,596	1,704,891	81,179,487

Note: SMF Sacramento International Airport
MRY Monterey Peninsula Airport
SCK Stockton Metropolitan Airports

High-Speed Rail Scenario – Base Case Forecast

	OAK	SFO	SJC	Total Airports
Total annual passengers	17,616,075	44,214,784	13,420,348	75,251,207
Total passenger access time (hr)	14,006,261	40,223,065	8,887,587	63,116,913
Total passenger access distance (000 mi)	500,602	1,399,871	353,966	2,254,439
Total access cost (\$000)	365,864	935,585	253,741	1,555,191
VTM (000)	488,884	1,065,614	331,753	1,886,251
VTM per passenger	27.75	24.10	24.72	25.07
Average passenger access distance (mi)	26.73	30.75	26.17	29.96
Average passenger access time (hr)	0.795	0.910	0.662	0.839
Average cost per passenger (\$)	20.77	21.16	18.91	20.67
GHG (CO2) emissions (metric ton/day)	429	935	291	1,655
NOx + HC emissions (metric ton/day)	0.156	0.340	0.106	0.601

	Total Airports	HSR Stations	Total
Total annual passengers	75,251,207	5,928,280	81,179,487
Total passenger access time (hr)	63,116,913	3,365,808	66,482,721
Total passenger access distance (000 mi)	2,254,439	99,526	2,353,965
Total access cost (\$000)	1,555,191	110,317	1,665,507
VTM (000)	1,886,251	81,578	1,967,829
VTM per passenger	25.07	13.76	24.24
Average passenger access distance (mi)	29.96	16.79	29.00
Average passenger access time (hr)	0.839	0.568	0.819
Average cost per passenger (\$)	20.67	18.61	20.52
GHG (CO2) emissions (metric ton/day)	1,655	72	1,726
NOx + HC emissions (metric ton/day)	0.601	0.026	0.627



Bay Area Airports Emission Inventory for Base Year (2007) and Target Analysis Scenarios in 2035

Draft Final Technical Report

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Baseline and Target Analysis Scenarios

To evaluate the impacts of the Bay Area Airports on the region's air quality, emission inventories were developed for each of the major airports (San Francisco International (SFO), Oakland International (OAK), and Norman Y. Mineta San Jose International (SJC)) for each target analysis scenario and for the current and future baseline scenarios.¹ The base year emission inventory for 2007 was developed based on reported aircraft operations and modeled taxi delay. Future year emission inventories for 2035 were modeled using projected estimates of aircraft operations and taxi delay. These included the 2035 baseline and six target analysis scenarios (Table E-1). These scenarios are further described in the *Target Analysis Approach for Analyzing Regional Airport System Strategies* memo from RAPC staff, dated September 25, 2009.

Airport emission estimates were made for PM₁₀, PM_{2.5}, NO_x, SO₂, volatile organic compounds (VOC), CO, CO₂, N₂O, CH₄, and total greenhouse gases (GHG)² as CO₂-equivalent³, for aircraft as well as for ground support equipment (GSE), and auxiliary power units (APU). The primary pollutants emitted at the Bay Area airports are NO_x, CO, VOC and CO₂. These airport emissions are a small fraction of the total Bay Area emissions. Airport related NO_x emissions compose 4.0% of the total Bay Area NO_x emissions, followed by VOC at 2.7%, CO₂ at 2.6% and CO at 2.1%.

The Bay Area is in federal non-attainment for both PM_{2.5} and ozone⁴. GSE emissions were included in the 2007 emission inventory using default aircraft assignments as used in the Emission Dispersion Modeling System (EDMS). The GSE CO emissions contribute the largest percentage to the total airport emissions ranging from 35.6% at OAK to 52.8% at SFO; GSE NO_x percentage ranges from 11% at SFO to 16.8% at SJC; and VOC percentages range from 11% at SFO to 16.8% at SJC, with GSE CO₂ emissions much smaller at just about 2% at each airport. All three of the Bay Area Airports have long-term objectives to electrify GSE. These efforts represent a significant reduction in future GSE emissions of CO, VOC and NO_x. Thus the analysis has assumed that by 2035 all ground support equipment (GSE) at the three Bay Area Airports will be electrified⁵ resulting in no on-airport emissions from GSE.

An overview of the emission inventory is presented in the next section which details the consistent methodological approach used in developing the emission inventory for each scenario. Model results are then presented with discussion about the findings for each scenario.

¹ Emissions from passenger ground vehicles accessing the airport were also calculated by the study team and are reported separately in the "Ground Access Analysis Methodology and Results" technical paper.

² Emission factors for CH₄ and N₂O used the Airport Cooperative Research Program (ACRP) Report 11, Guidebook on Preparing Airport GHG Emission Inventories (2009) and reported as CO₂ equivalent. However, the contribution of these emissions relative to CO₂ emissions is a small (<1%) fraction of the total GHG emissions.

³ CO₂-equivalent is the [quantity](#) of greenhouse gases which have equivalent global warming potential as CO₂ only when measured over 100 years.

⁴ NO_x and VOC are the primary contributors to ozone formation.

⁵ Under AB 32 (Global Warming Solutions Act, 2006) a 40% decrease over 1990 levels is targeted in aircraft generated CO₂ emissions. All three Bay Area airports have aggressive emission reduction programs underway for GSE emission reductions including baggage handling and electrification of terminals gates along with inducements to encourage each airline and cargo handler for conversion to electric GSE (Airports Council International, Environmental Initiatives Around the World, Case Study 14 – Air quality high on the agenda at Oakland International Airport, July, 2007).

Overview of Emission Inventory Development

The general approach in developing the Bay Area Aircraft Emission Inventory was to develop an airport specific emission inventory for each of the three major airports in the region (SFO, OAK, SJC) using the latest version of FAA's EDMS 5.1.1 tool. No explicit calculations were made for other smaller airports in the region. However for the Internal Regional Airports scenario (Case 3) which involves new air services at secondary Bay Area airports (Charles M. Schulz – Sonoma County Airport (STS), Buchanan Field Airport in Concord (CCR) , and Travis Air Force Base in Fairfield (SUU)) the incremental aircraft emissions associated with the assumed air services at the secondary airports were calculated. Further details on the emission inventory are described in the following section.

TABLE E-1. TARGET ANALYSIS SCENARIOS

Case	Name	Years
Case0a	Base Year	2007
Case0b	Baseline	2035
Case1	Redistribution	2035
Case2	External Regional Airports	2035
Case3	Internal Regional Airports	2035
Case4	High Speed Rail	2035
Case5	ATC Technology	2035
Case6	Demand Management	2035
Case7	Continuous Descent Approach	2035

Emission Inventory Development for Three Bay Area Major Airports

EDMS has two approaches for determining times in mode for the aircraft during flight: a dynamic Aircraft Performance based module and ICAO/EPA default values based on aircraft category. The dynamic aircraft performance module requires additional data as input on specific aircraft and engine characteristics as well as weather data to dynamically model each aircraft flight. Because our focus for this analysis is on a comparison between the scenarios, which will not change as a result of using the aircraft performance module, we used the more simplified approach of using the default time in mode values.

Taxi Delay Calculations

While EDMS has its own queuing model, WWLMINET, which predicts hourly airport ground and approach delay, considerable effort has already been undertaken using FTA's FLAPS and DELAYSIM models to determine capacity and aircraft delay. For consistency with the runway capacity and delays analysis, we relied on the runway taxi delay estimates from DELAYSIM to estimate taxi-in, taxi-out and approach times including delay. Future improvements that may reduce delay, such as advancements in air traffic control (ATC) technology and demand management (e.g., Cases 5 and 6), were accounted for in the emissions calculations to the extent they are included in the FLAPS and DELAYSIM modeling.

Baseline, unimpeded taxi-in and taxi-out times were determined for each of the three principal airports using information in the ASPM/APM FAA databases.⁶ Raw taxi times, including

⁶ <http://aspm.faa.gov/information.asp>

impeded and unimpeded, characterized by air carrier and season, were taken from the ASPM interface. The number of departures and arrivals by airline by month were taken from the APM database. Months were then assigned to seasons and the two databases combined to calculate annual average taxi in/out times weighted by the number of departures or arrivals for taxi-out or taxi-in, respectively. The unimpeded taxi-in and taxi-out times for SFO were 4.58 and 13.29 minutes, respectively. OAK and SJC had unimpeded taxi-in times of 5.08 and 3.29 minutes, respectively, and unimpeded taxi-out times of 8.92 and 9.46 minutes, respectively. These measured unimpeded taxi delay times for 2007 were assumed unchanged for 2035. Impeded taxi-out times were derived by combining the unimpeded taxi-out times with the taxi delay values derived from the FLAPS and DELAYSIM model for a given scenario. Finally, impeded taxi-in times were estimated to be equal to the unimpeded taxi-in times, since taxi delays to arriving flights occur at the origin airport and not the destination airport. This assumes all other delay occurs outside of the airspace in question (40 nm horizontal radius for greenhouse gas emission calculations and 2,300 vertical feet for criteria pollutants, as discussed below). Table E-2 shows the total (impeded plus unimpeded) taxi-in, taxi-out, and total taxi times for each airport for each scenario. Taxi delays at secondary airports (Case 3) were assumed to be equal to those at SJC , as these are the lowest of the DELAYSIM-modeled values.

TABLE E-2. AVERAGE TOTAL TAXI TIME FOR EACH TARGET ANALYSIS SCENARIO.

Case	Scenario	Year	SFO			SJC			OAK		
			Total (min)	Taxi-In (min)	Taxi-Out (min)	Total (min)	Taxi-In (min)	Taxi-Out (min)	Total (min)	Taxi-In (min)	Taxi-Out (min)
Case0a	Base Year	2007	23.95	4.58	19.37	13.14	3.29	9.86	14.90	5.08	9.82
Case0b	Baseline	2035	35.31	4.58	30.74	13.09	3.29	9.80	16.25	5.08	11.17
Case1	Airport Redistribution	2035	26.06	4.58	21.48	13.14	3.29	9.85	16.74	5.08	11.66
Case2	External Regional Airports	2035	30.82	4.58	26.25	13.08	3.29	9.79	16.29	5.08	11.21
Case3	Internal Regional Airports	2035	29.12	4.58	24.54	13.08	3.29	9.80	15.75	5.08	10.67
Case4	High Speed Rail	2035	27.48	4.58	22.90	13.01	3.29	9.73	15.66	5.08	10.58
Case5	ATC Improve	2035	34.06	4.58	29.48	13.09	3.29	9.80	15.55	5.08	10.46
Case6	Demand Management	2035	28.71	4.58	24.14	13.09	3.29	9.80	16.25	5.08	11.17

Emissions were calculated for GSE (in the baseline year only), APUs, and the five aircraft operating modes in the EDMS model: taxi-out, takeoff, climb-out, approach, and taxi-in. The sum across all modes gives the total emissions for a particular aircraft type and the sum of all emissions across all aircraft types (sizes, designation, engine type and uses) determines the total annual emissions for the airport. Generally, the emissions for criteria pollutants and greenhouse gases (GHG) were calculated similarly. However, separate simulations and post-processing were required due to altitude limitations in the EDMS model.

Criteria Pollutant Emission Calculations

EDMS assigns aircraft engine combinations as typically found at each airport which usually only vary across international regions. These default engine types are based on the actual engine type which is the most common or the most widely used engine type for that particular aircraft type in the United States based on data as extracted from the BACK aviation database (http://www.backaviation.com/information_services/products/schedules.htm). In cases where defaults are not available, a reasonable substitute alternative was used. All aircraft Time-in-mode (TIM) values are set to ICAO/EPA defaults, except taxi times, which were estimated as described above. All aircraft were assigned an engine(s). No APUs were used for plane types labeled as multi-engine land (MEL), single engine land (SEL), turboprop (TP), military (MIL), and local (LOC), unless a default exists in EDMS. For other types (business jet (BJ), air cargo (AC), and passenger) the default APU is used if available. No changes were made to default assignments of GSE. All modeled activity was understood to be operations, where one operation is taken as either a departure or landing. To determine activity in EDMS, the modeled values were divided by 2 and this value distributed among all the relevant plane sub-types. Furthermore, all aircraft activity was modeled in EDMS as landing-take offs (LTOs) for all plane types except local operations (LOC), which were modeled as touch-and-go's (TGOs) combined with the default taxi-times, as available in EDMS, for these general aviation aircraft. For example, the 2035 OAK baseline scenario has 18,305 local operations for Cesena-152s. This was included in the model as 18,305 arrivals and 18,305 departures. The same scenario also shows 152,645 operations for passenger aircraft type "737-700/800/900". This was modeled as 25,441 LTOs for each of Boeing 737-700, 737-800, and 737-900 aircraft. For future years, in cases where aircraft not currently available are used (principally the Boeing 787 and Airbus A350), the most similar extant aircraft and engine in the database was assumed. (These were the Boeing 767-200 Series with a CF6-80A engine and Airbus A340-600 Series with a Trent 556-61 Phase 5 tiled engine, respectively). Other aircraft substitutions were sometimes necessary to resolve discrepancies in the modeled activity and those types available in the database. Although infrequently occurring in the model, this was done using the best-available match. Table E-3 shows these substitutions.

Table E-3. Aircraft substitutions used for missing aircraft types in EDMS

Plane Type (EDMS Name)	Engine Type (EDMS Name)	Used as a Surrogate for (FLAPS/Activity Modeling Name)
BEECH36	TIO540	BE35
BEECH60	TIO540	BE76
BEECH99	PT6A36	BE95
CNA150	O200	C152
CNA525	1PW035	C25A
CNA525	1PW035	C25B
DHC8-3	PW123	DH8D
DHC8-3	PW123	DHC8-400
GLOBALEXPRESS	4BR009	GL5T
GULF2-B	1RR016	GLF3
MD81	4PW070	MD80
MIL-T2	J852	T33
PA23	TIO540	PA18
PA46T	PT6A42	UNK
SA226	TPE3U	SW4

Criteria pollutant emissions were calculated up to an altitude of 2,300 feet, the default annual average mixing depth in the Bay Area⁷ (BAAQMD, 2004). This is also the value used by the BAAQMD in developing their inventory for Bay Area aircraft emissions. All criteria pollutant emissions were determined directly in the EDMS model.

GHG Emission Calculations

CO₂, CH₄ and N₂O emissions were determined based on simulations similar to those for criteria pollutants, although some modifications to the model output were necessary. Principally, this involved calculating emissions out to a horizontal distance of 40 nm (radius) from each airport rather than up to a vertical height of 2,300 ft. This was done to be consistent with the approach the BAAQMD adopted in developing their GHG emission inventory. This distance is approximately equivalent to the average travel distance within the nine-county airspace of 80 nautical miles per operation (diameter) as a composite distance across the three airports. The approach vertical height at 40 nautical miles was estimated at 12,700 and a departure height of 25,500 ft. However, the EDMS model is limited to vertical calculations of less than or equal to 10,000 ft. Thus, the following approach was used for determining the GHG emissions. The model was run once for the criteria emissions with a vertical extent of 2,300 ft and again for GHG emissions with a vertical extent of 10,000 ft. Total fuel consumption for all aircraft were then computed for each mode from both simulations. The difference in these values was used to determine total fuel consumption per vertical foot by mode in the 2,300 to 10,000 ft range. This value was assumed to also apply above 10,000 feet. Thus, a linear extrapolation up to the 12,700 feet (approach) or 25,500 feet (departure) threshold was performed by mode to determine the total fuel consumption within a 40 nm horizontal distance of any airport.

GHG emissions were then determined from the extrapolated fuel consumption values. CO₂ emissions are based on ICAO emission factors as used in EDMS for typical jet fuel (3.15 g/g of fuel) and aviation gasoline for piston engined aircraft. This is equivalent to the BAAQMD's fuel based CO₂ emission factor of 21.1 lb/gallon of jet fuel assuming a jet fuel density of 6.7 lbs per gallon. An N₂O emission factor of 2.96E-02 (g CO₂e per g fuel) was used, which incorporates a CO₂e value for N₂O of 296.⁸ CH₄ emissions up to 10,000 ft were calculated using the EDMS calculated values of VOC, with the CH₄ fraction of total VOC taken as 10%.⁹ Total CH₄ emissions within 40 nm were then calculated by applying the ratio of total fuel consumption within 40 nm horizontally to fuel consumption within 10,000 vertical feet.

Continuous Descent Approach (CDA)

CDA emission changes relative to non-CDA emissions were derived from research funded by the FAA Office of Environment and Energy (Dinges, 2008)¹⁰. CDA does not affect the criteria pollutant emission calculations for this study because below 2,300 ft the CDA and non-CDA

⁷ Steinberger, Joseph, 2004 "General Aviations Contribution to Emissions", Senior Planner BAAQMD, March 2004 presented at the Jet Set Go, Environmental Aviation Takes Off Program, March 2004.

⁸ *Procedure for the Calculation of Aircraft Emissions*, SAE Document Number: AIR5715, July 2009, p46

⁹ *Procedure for the Calculation of Aircraft Emissions*, SAE Document Number: AIR5715, July 2009, p44

¹⁰ Dinges, EP. 2008. "Determining the Environmental Benefits of Implementing Continuous Descent Arrival Procedures", Paper #594 presented at the Annual Conference of the 101st Air & Waste Management Association, June 2008, Portland OR.

approaches are essentially identical. The difference in CDA's approach typically takes place between 10,000 ft and 3,000 ft with a net reduction in GHG emissions due to reduced fuel consumption during approach which averages about 24.2% (Dinges, 2008). The reduced fuel consumption was based on twenty-four days of data from FAA/NASA Performance Data Analysis and Reporting System using LAX radar data to define the average daily flight operations and the baseline flight profiles. This information was then combined with FAA's Aviation Environmental Design Tool which contains aircraft performance data necessary to derive thrust, which in combination with aircraft engine emission indices (g of pollutant/kg of fuel burned) was used to determine emission changes. The emission reduction changes developed by Dinges were applied assuming all aircraft would land using CDA.

Emission Inventory Development for Other Airports within the Nine-County Region

Emissions from aircraft operations at other airports were only included for the Internal Secondary Airports Scenario (Case 3), which involves changes that shift aircraft activity from one or more of the three primary airports to alternative secondary airports in the region. As identified in the Target Analysis Approach for Analyzing Regional Airport System Strategies, emissions at airports outside the region, which applies to the External Airports Scenario (Case 2), were not quantified. In this scenario the number of operations at the primary airports is reduced as the external airports gain new services and fewer passengers from the external airport market areas travel to the primary Bay Area airports for air service. While emissions within the Bay Area region decline, there is an increase in emissions at the external airports.

High Speed Rail (HSR) Scenario

For the HSR Scenario (Case 4) the estimated change in aircraft emissions was based on the reduction in aircraft operations and corresponding reduction in taxi delay. In addition, an analysis comparing GHG emissions from high speed rail and aircraft operations was developed. The comparison was done on a per passenger mile basis for each airport based on projected passenger load and aircraft operations bound for the Southern California market for the least fuel efficient aircraft (A-321) and the most fuel-efficient aircraft (A-319) used in that market. Air passenger load factors in Southern California markets ranged from 70.4% at SFO to 76.3% at SJC. Emissions from high speed rail were determined on a per passenger basis¹¹ for two top speed rail configurations (175 mph and 220 mph) for the current baseline energy mix, a 33% renewable energy mix (currently targeted by the state for 2020), and a 50% renewable energy mix. The current mix of non-renewable fuels is 45.7% natural gas, 18.2% coal, and 14.5% nuclear; the 33% renewable mix had non-renewables of 39.1% natural gas, 15.6% coal, and 12.3% nuclear; the 50% renewable mix had non-renewables of 29.2% natural gas, 8.5% coal, and 12.3% nuclear. Since California has no coal power plants adjustments for electrical transmission, losses from the burning of coal were made assuming an 8.5% transmission loss per 100 miles over 765kV lines over a distance of 500 miles.

Resulting Emissions and Discussion

Predicted Emissions and Emissions Changes by Scenario

Tables E-4 through E-36 show the predicted emissions from each of the three airports for the 2007 and 2035 baseline and for the 2035 target analysis scenarios. In each case, the

¹¹ Per passenger mile energy requirement based on the energy requirement reported in *the Bay Area to Central Valley High Speed Train Final Program EIR/EIS*, Volume 1, May 2008, Chapter 3.5 Energy, for a 16-car train set with a 1,200 passenger carrying capacity with an average of 994 passengers (82.8% occupancy rate).

emissions represent the total at each airport except for the Internal Regional Airports scenario (Case 3). In that case, the emissions at the three primary airports (SFO, OAK, SJC) represent the total emissions at those airports, but emissions at the three secondary airports (CCR, STS, SUU) only represent the change in activity above their respective baseline values. Emissions are reported for aircraft, auxiliary power units (APU), and ground support equipment (GSE) (only for 2007). By 2035 all GSE are assumed to be electrified and thus produce zero on-site emissions.

The first set of tables shows the results for the 2007 base year and the 2035 baseline scenarios, while subsequent tables show the modeled emissions for each target analysis scenario and their reduction relative to the future baseline scenario. In all cases, the relative reductions are defined as:

$$\text{Percent Relative Reduction} = (\text{value for scenario case} - \text{value for baseline case}) / (\text{value for baseline case}) \times 100$$

In examining the emission totals it should be noted that the emission rates vary substantially by operating mode particularly for NO_x and VOC. In general, jet aircraft produce substantially more NO_x than VOC (2-7 times depending upon aircraft performance characteristics) over an LTO cycle. However, most (> 70%) of the NO_x emissions occur during the takeoff and climb-out modes.

Additionally, most of the CO emissions from aircraft occur during taxi-in or taxi-out, ranging from 33% to 96% with the highest percentages occurring where taxi delay times are highest. Most of the VOC emissions occur during taxi operations ranging from a low of 60% up to 93% again with the highest percentages occurring where delays are largest. NO_x however exhibits the reverse pattern where most NO_x emissions occur during aircraft flight (77-87%). Finally, 94-96% of CO₂ emissions occur during flight.

Baseline (2007) and Future Baseline (2035) Scenario

Table E-4 shows the modeled criteria pollutant emissions for each airport. Table E-5 shows a comparison between the results found in this study with the criteria emission inventory developed by Bay Area Air Quality Management District (BAAQMD) for 2005¹². Table E-6 summarizes the total greenhouse gas emissions and Table E-7 compares the 2007 baseline to the inventory developed independently by the Bay Area Air Quality Management District (BAAQMD) which was available for 2007¹³.

In Table E-4 an emission comparison between the 2035 baseline and 2007 shows that CO and VOC emissions increase substantially at SFO while both OAK and SJC show small decreases. The primary cause for this is the significant increase in average taxi time of just over 11.4 minutes at SFO compared to an increase of just 1.3 minutes at OAK and almost no change at SJC (Table E-2). In addition, the elimination of the GSE emissions was sufficient at OAK and SJC to overcome the increase in aircraft activity. In all cases NO_x emissions showed increases with a near doubling of emissions for SFO.

¹² Base Year 2005 Emission Inventory Summary Report, BAAQMD, December 2008. Prepared by the Emission Inventory Section.

¹³ Source Inventory of Bay Area Greenhouse Gas Emissions, BAAQMD, December, 2008

Table E-5 compares the results of this study for the baseline year (2007) to BAAQMD 2005 inventory. Exact agreement is not expected due to the different modeling methodologies¹⁴, different numbers of aircraft operations and aircraft types, different taxi delay values and different analysis years. Comparisons are only made for CO, VOC and NO_x as the reported values for PM and SO_x were only reported at less than 0.1 ton per day. In general, results are similar although the largest difference is seen for SJC where the BAAQMD estimates are 30-50% higher. This could be due to differences in the default taxi-in/taxi-out delay times used in the BAAQMD analysis or, possibly, to declining activity between the two years.

Table E-6 shows that the CO₂e will increase by about 50% at SJC and OAK, but nearly double for SFO under the future baseline scenario. As a basis of quality assurance, the CO₂ emissions for 2007 baseline scenario (Case 0a) are compared with those derived by the Bay Area Air Quality Management District's 2007 Greenhouse Gas Emission Inventory. Table E-7 compares the modeled results for 2007 to the average daily results for 2005 calculated by the BAAQMD. Again, exact agreement is not expected due to the different modeling methodologies, activity level assumptions, and taxi-time values. However, the results demonstrate a reasonably strong agreement. SJC showed the greatest discrepancy, with the findings about 24% higher than the BAAQMD results. OAK is in very close agreement, while the results for SFO are about 11% lower than the BAAQMD.

¹⁴ BAAQMD used a projected fleet of aircraft, this analysis used reported; BAAQMD used default time-in-mode, while this analysis used specific aircraft/engine performance data as available within EDMS.

TABLE E-4. CRITERIA POLLUTANT EMISSIONS FOR 2007 BASELINE (CASE 0A) AND 2035 FUTURE BASELINE (CASE0B).

	Criteria Air Pollutants					
	CO (kg)	VOC (kg)	NOx (kg)	SOx (kg)	PM-10 (kg)	PM-2.5 (kg)
2007 OAK EDMS Aircraft Total	2,319,978	204,114	837,280	83,146	11,794	11,794
EDMS GSE Total	1,306,191	45,072	144,727	7,750	4,514	4,342
EDMS APU Total	45,449	3,313	32,823	5,086	4,956	4,956
Total, All	3,671,618	252,499	1,014,831	95,982	21,264	21,092
SFO EDMS Aircraft Total	2,536,739	729,518	1,978,801	190,683	33,774	33,774
EDMS GSE Total	2,201,447	77,031	253,978	13,808	8,503	8,186
EDMS APU Total	71,764	5,562	68,708	9,550	9,166	9,166
Total, All	4,809,950	812,111	2,301,487	214,040	51,442	51,126
SJC EDMS Aircraft Total	768,371	117,084	458,606	47,583	7,267	7,267
EDMS GSE Total	895,632	30,687	97,115	5,092	2,879	2,767
EDMS APU Total	32,966	2,392	22,175	3,544	3,547	3,547
Total, All	1,696,969	150,163	577,896	56,219	13,693	13,581
2035 OAK EDMS Aircraft Total	1,876,012	199,833	1,349,178	114,759	16,218	16,218
EDMS APU Total	37,230	2,985	50,728	6,930	5,471	5,471
EDMS GSE Total	-	-	-	-	-	-
Total, All	1,913,242	202,817	1,399,906	121,689	21,689	21,689
SFO EDMS Aircraft Total	5,733,852	1,756,167	4,166,850	423,643	77,681	77,681
EDMS APU Total	89,181	6,873	115,800	15,039	13,039	13,039
EDMS GSE Total	-	-	-	-	-	-
Total, All	5,823,033	1,763,039	4,282,650	438,682	90,721	90,721
SJC EDMS Aircraft Total	739,329	99,798	716,741	63,204	9,300	9,300
EDMS APU Total	27,852	2,024	35,467	4,754	3,843	3,843
EDMS GSE Total	-	-	-	-	-	-
Total, All	767,182	101,821	752,207	67,958	13,143	13,143

Airport Redistribution Scenario (Case 1)

For the redistribution scenario (Table E-8), SFO criteria pollutant emissions decreased by about 10-27% depending on pollutant for aircraft and from 5 to 6 percent for auxiliary power units (APUs) with an overall decrease of about 10-27 percent. As would be expected, OAK and SJC criteria pollutant emissions increased from 5-10% for OAK and from 6-11% for SJC (Table E-9). GHG emissions (Tables E-10 and E-11) increase by about 10% at both OAK and SJC, and decrease by about 11% at SFO. However the net effect for implementing a redistribution plan would be to reduce overall GHG emissions by about 4%.

TABLE E-8. CRITERIA POLLUTANT EMISSIONS FOR AIRPORT REDISTRIBUTION (CASE 1).

			Criteria Air Pollutants					
			CO (kg)	VOC (kg)	NOx (kg)	SOx (kg)	PM-10 (kg)	PM-2.5 (kg)
2035	OAK	EDMS Aircraft Total	1,964,176	214,882	1,463,271	125,699	17,833	17,833
		EDMS APU Total	40,138	3,227	54,595	7,484	5,924	5,924
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	2,004,314	218,109	1,517,866	133,183	23,757	23,757
	SFO	EDMS Aircraft Total	4,173,324	1,324,607	3,750,528	341,711	61,567	61,567
		EDMS APU Total	85,049	6,532	108,561	14,163	12,369	12,369
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	4,258,372	1,331,139	3,859,089	355,874	73,936	73,936
	SJC	EDMS Aircraft Total	779,727	107,516	793,906	69,861	10,331	10,331
		EDMS APU Total	30,186	2,208	38,684	5,181	4,192	4,192
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	809,913	109,723	832,589	75,042	14,524	14,524

TABLE E-9. CHANGE IN CRITERIA POLLUTANT EMISSIONS, AIRPORT REDISTRIBUTION (CASE 1) VERSUS 2035 BASELINE.

Criteria Pollutants, 2035		CO	VOC	NOx	SOx	PM-10	PM-2.5
OAK	EDMS Aircraft Total	4.70%	7.53%	8.46%	9.53%	9.96%	9.96%
	EDMS APU Total	7.81%	8.13%	7.62%	7.99%	8.27%	8.27%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	4.76%	7.54%	8.43%	9.45%	9.53%	9.53%
SFO	EDMS Aircraft Total	-27.22%	-24.57%	-9.99%	-19.34%	-20.74%	-20.74%
	EDMS APU Total	-4.63%	-4.95%	-6.25%	-5.82%	-5.14%	-5.14%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-26.87%	-24.50%	-9.89%	-18.88%	-18.50%	-18.50%
SJC	EDMS Aircraft Total	5.46%	7.73%	10.77%	10.53%	11.09%	11.09%
	EDMS APU Total	8.38%	9.09%	9.07%	8.98%	9.09%	9.09%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	5.57%	7.76%	10.69%	10.42%	10.51%	10.51%

TABLE E-10. GREENHOUSE GAS EMISSIONS FOR AIRPORT REDISTRIBUTION (CASE 1).

Greenhouse Gases											
			OAK	SFO	SJC				OAK	SFO	SJC
2035	CO2 (kg)	Aircraft	796,470,414	2,060,320,307	450,841,899	2035	CO2e (kg)	Aircraft	804,906,512	2,085,111,762	455,540,793
		GSE	-	-	-			GSE	-	-	-
		APU	10,855,293	20,543,760	7,514,691			APU	10,937,890	20,700,076	7,571,870
		Total	807,325,707	2,080,864,067	458,356,590			Total	815,844,402	2,105,811,837	463,112,663

TABLE E-11. CHANGE IN CO2E EMISSIONS, AIRPORT REDISTRIBUTION (CASE 1) VERSUS 2035 BASELINE.

CO2e, 2035	OAK	SFO	SJC
Aircraft	8.6%	-11.1%	10.4%
GSE	n/a	n/a	n/a
APU	8.0%	-5.8%	9.0%
Total	8.6%	-11.0%	10.4%

External Regional Airport Scenario (Case 2)

In the External Regional Airports Scenario (Tables E-12 and E-13), all three principal Bay Area airports show reductions relative to the 2035 baseline, but reductions range from 0 to 12% depending upon the airport and the pollutant. Table E-14 shows the greenhouse gas emissions and relative reduction in GHG emissions for the External Regional Airports scenario. GHG emissions (Tables E-14 and E-15) decreased by approximately 1.5% to 4%, however the net effect for implementing an external regional redistribution plan would be to reduce overall GHG emissions by only about 3% and if external airport emissions were included this reduction would be even less.

TABLE E-12. CRITERIA POLLUTANT EMISSIONS FOR EXTERNAL REGIONAL AIRPORTS (CASE 2).

			Criteria Air Pollutants					
			CO (kg)	VOC (kg)	NOx (kg)	SOx (kg)	PM-10 (kg)	PM-2.5 (kg)
2035	OAK	EDMS Aircraft Total	1,866,566	198,082	1,328,566	113,026	15,961	15,961
		EDMS APU Total	36,672	2,938	49,987	6,824	5,385	5,385
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	1,903,237	201,020	1,378,553	119,850	21,346	21,346
	SFO	EDMS Aircraft Total	5,057,904	1,567,627	4,042,170	391,774	70,942	70,942
		EDMS APU Total	88,811	6,840	115,055	14,950	12,973	12,973
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	5,146,715	1,574,467	4,157,225	406,723	83,915	83,915
	SJC	EDMS Aircraft Total	723,035	96,666	684,959	60,478	8,877	8,877
		EDMS APU Total	26,889	1,948	34,138	4,577	3,699	3,699
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	749,924	98,614	719,097	65,055	12,575	12,575

TABLE E-13. CHANGE IN CRITERIA POLLUTANT EMISSIONS, EXTERNAL REGIONAL AIRPORTS (CASE 2) VERSUS 2035 BASELINE.

Criteria Pollutants, 2035		CO	VOC	NOx	SOx	PM-1	PM-2
OAK	EDMS Aircraft Total	-0.50%	-0.88%	-1.53%	-1.51%	-1.58%	-1.58%
	EDMS APU Total	-1.50%	-1.56%	-1.46%	-1.53%	-1.59%	-1.59%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-0.52%	-0.89%	-1.53%	-1.51%	-1.58%	-1.58%
SFO	EDMS Aircraft Total	-11.79%	-10.74%	-2.99%	-7.52%	-8.68%	-8.68%
	EDMS APU Total	-0.41%	-0.47%	-0.64%	-0.60%	-0.51%	-0.51%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-11.61%	-10.70%	-2.93%	-7.29%	-7.50%	-7.50%
SJC	EDMS Aircraft Total	-2.20%	-3.14%	-4.43%	-4.31%	-4.55%	-4.55%
	EDMS APU Total	-3.46%	-3.75%	-3.75%	-3.71%	-3.75%	-3.75%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-2.25%	-3.15%	-4.40%	-4.27%	-4.32%	-4.32%

TABLE E-14. GREENHOUSE GAS EMISSIONS FOR EXTERNAL REGIONAL AIRPORTS (CASE 2).

Greenhouse Gases											
		OAK			SFO			SJC			
2035	CO2 (kg)	Aircraft	721,989,317	2,236,506,308	390,686,947	2035	CO2e (kg)	Aircraft	729,658,960	2,263,721,440	394,775,034
		GSE	-	-	-			GSE	-	-	-
		APU	9,898,255	21,684,073	6,639,406			APU	9,973,570	21,849,065	6,689,924
	Total		731,887,572	2,258,190,380	397,326,353		Total		739,632,530	2,285,570,505	401,464,959

TABLE E-15. CHANGE IN CO2E EMISSIONS, EXTERNAL REGIONAL AIRPORTS (CASE 2) VERSUS 2035 BASELINE.

CO2e, 2035	OAK	SFO	SJC
Aircraft	-1.53%	-3.47%	-4.30%
GSE	n/a	n/a	n/a
APU	-1.53%	-0.60%	-3.71%
Total	-1.53%	-3.44%	-4.29%

Internal Regional Airport Scenario (Case 3)

In the Internal Regional Airports Scenario, criteria emissions decrease at all three principal airports, with SFO showing the largest percentage decrease (5-17%). At SJC emissions decrease by 5-10% and at OAK the decline in emissions is 3-6%. (Table E-17) However, additional emission increases will occur at the secondary airports, as shown in Tables E-18 and E-21. Tables E-19 and E-20 show a decrease in GHG emissions at the 3 major airports. Inclusion of the 3 secondary airports results in a net decrease in GHG emissions of about 1.5% over the 2035 baseline scenario.

TABLE E-16. CRITERIA POLLUTANT EMISSIONS AT PRIMARY AIRPORTS FOR INTERNAL REGIONAL AIRPORTS (CASE 3).

			Criteria Air Pollutants					
			CO (kg)	VOC (kg)	NOx (kg)	SOx (kg)	PM-10 (kg)	PM-2.5 (kg)
2035	OAK	EDMS Aircraft Total	1,815,803	189,664	1,282,451	108,060	15,230	15,230
		EDMS APU Total	35,568	2,846	48,519	6,614	5,213	5,213
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	1,851,371	192,510	1,330,971	114,674	20,442	20,442
	SFO	EDMS Aircraft Total	4,760,847	1,483,896	3,965,913	376,492	67,974	67,974
		EDMS APU Total	88,086	6,781	113,785	14,796	12,855	12,855
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	4,848,933	1,490,676	4,079,697	391,288	80,830	80,830
	SJC	EDMS Aircraft Total	738,195	99,579	714,494	63,012	9,270	9,270
		EDMS APU Total	27,784	2,018	35,372	4,741	3,833	3,833
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	765,979	101,597	749,867	67,754	13,103	13,103

TABLE E-17. CHANGE IN CRITERIA POLLUTANT EMISSIONS, INTERNAL REGIONAL AIRPORTS (CASE 3) VERSUS 2035 BASELINE.

Criteria Pollutants, 2035		CO	VOC	NOx	SOx	PM-1	PM-2
OAK	EDMS Aircraft Total	-3.21%	-5.09%	-4.95%	-5.84%	-6.09%	-6.09%
	EDMS APU Total	-4.46%	-4.64%	-4.35%	-4.56%	-4.72%	-4.72%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-3.23%	-5.08%	-4.92%	-5.76%	-5.75%	-5.75%
SFO	EDMS Aircraft Total	-16.97%	-15.50%	-4.82%	-11.13%	-12.50%	-12.50%
	EDMS APU Total	-1.23%	-1.34%	-1.74%	-1.62%	-1.41%	-1.41%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-16.73%	-15.45%	-4.74%	-10.80%	-10.90%	-10.90%
SJC	EDMS Aircraft Total	-5.33%	-7.38%	-10.00%	-9.80%	-10.27%	-10.27%
	EDMS APU Total	-7.96%	-8.58%	-8.56%	-8.49%	-8.58%	-8.58%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-5.42%	-7.41%	-9.94%	-9.71%	-9.78%	-9.78%

TABLE E-18. ADDITIONAL CRITERIA POLLUTANT EMISSIONS FOR SECONDARY AIRPORTS (CASE 3).

			Criteria Air Pollutants					
			CO (kg)	VOC (kg)	NOx (kg)	SOx (kg)	PM-10 (kg)	PM-2.5 (kg)
2035	CCR	EDMS Aircraft Total	25,680	2,993	46,885	5,597	555	555
		EDMS APU Total	2,028	221	1,442	314	288	288
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	27,708	3,213	48,326	5,911	843	843
	STS	EDMS Aircraft Total	12,478	1,455	22,714	2,716	269	269
		EDMS APU Total	986	107	701	153	140	140
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	13,464	1,562	23,415	2,869	410	410
	SUU	EDMS Aircraft Total	25,183	2,935	45,929	5,486	544	544
		EDMS APU Total	1,989	216	1,414	308	283	283
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	27,172	3,152	47,343	5,794	827	827

TABLE E-19. GREENHOUSE GAS EMISSIONS FOR PRIMARY AIRPORTS IN THE INTERNAL REGIONAL AIRPORTS SCENARIO (CASE 3).

Greenhouse Gases											
		OAK	SFO	SJC			OAK	SFO	SJC		
2035	CO ₂ (kg)	Aircraft	696,000,265	2,188,621,743	406,986,870	2035	CO ₂ e (kg)	Aircraft	703,394,619	2,215,126,465	411,240,384
		GSE	-	-	-			GSE	-	-	-
		APU	9,593,447	21,461,283	6,877,046			APU	9,666,443	21,624,580	6,929,373
		Total	705,593,712	2,210,083,026	413,863,916			Total	713,061,061	2,236,751,045	418,169,757

TABLE E-20. CHANGE IN CO2E EMISSIONS, INTERNAL REGIONAL AIRPORTS (CASE 3) VERSUS 2035 BASELINE.

CO2e, 2035	OAK	SFO	SJC
Aircraft	-5.08%	-5.54%	-0.30%
GSE	n/a	n/a	n/a
APU	-4.56%	-1.62%	-0.26%
Total	-5.07%	-5.51%	-0.30%

TABLE E-21. ADDITIONAL GREENHOUSE GAS EMISSIONS FOR SECONDARY AIRPORTS IN THE INTERNAL REGIONAL AIRPORTS SCENARIO (CASE 3).

Additional Greenhouse Gas Emissions at Secondary Airports											
			CCR	STS	SUU				CCR	STS	SUU
2035	CO2 (kg)	Aircraft	43,431,712	21,101,974	42,589,642	2035	CO2e (kg)	Aircraft	43,852,542	21,306,447	43,002,317
		GSE	6,877,046	-	455,946			GSE	6,929,373	-	459,416
		APU	-	455,946	-			APU	-	459,416	-
		Total	50,308,758	21,557,920	43,045,588			Total	50,781,914	21,765,863	43,461,733

High Speed Rail Scenario (Case 4)

In the High Speed Rail Scenario, emissions are reduced as a result of both the reduced number of aircraft operations as well as decreases in aircraft taxi delay. The greatest percentage emission reductions are seen at SFO (7-22%), as shown in Tables E-22 and E-23. Higher emission reductions are seen for CO and VOC from the reduced taxi delay. Some of these emission reductions will be offset by increased emissions associated with the operation of the high speed rail. However, a net reduction should occur, due to the generally greater efficiency of rail over aircraft on a per passenger mile basis, but this depends upon the source of the electrical power for the operation of the high speed rail. Table E-25 shows that with the operation of the high speed rail, GHG emissions from the three Bay Area Airports would be reduced by 7-14%. Tables E-26 and E-27 show that GHG emissions from high speed rail produces less GHG emissions per passenger mile travelled. The HSR is the more efficient mode of travel ranging from a low efficiency of 2.2 (=152/68) which is the most fuel efficient aircraft and the highest speed train operating with today's energy mix to a high end efficiency of 8.7 (=253/29) operating with the lower train speeds and 50% renewable energy mix with the least efficient aircraft.

TABLE E-22. CRITERIA POLLUTANT EMISSIONS FOR HIGH SPEED RAIL (CASE 4).

			Criteria Air Pollutants					
			CO (kg)	VOC (kg)	NOx (kg)	SOx (kg)	PM-10 (kg)	PM-2.5 (kg)
2035	OAK	EDMS Aircraft Total	1,796,552	186,073	1,250,620	105,260	14,805	14,805
		EDMS APU Total	35,113	2,800	47,551	6,473	5,111	5,111
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	1,831,665	188,873	1,298,171	111,733	19,916	19,916
	SFO	EDMS Aircraft Total	4,449,717	1,400,760	3,874,185	359,062	64,723	64,723
		EDMS APU Total	86,170	6,629	111,596	14,484	12,586	12,586
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	4,535,887	1,407,389	3,985,781	373,546	77,309	77,309
	SJC	EDMS Aircraft Total	688,294	89,410	610,597	54,295	7,894	7,894
		EDMS APU Total	25,801	1,846	31,274	4,222	3,451	3,451
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	714,095	91,256	641,872	58,518	11,345	11,345

TABLE E-23. CHANGE IN CRITERIA POLLUTANT EMISSIONS, HIGH SPEED RAIL (CASE 4) VERSUS 2035 BASELINE.

Criteria Pollutants, 2035		CO	VOC	NOx	SOx	PM-10	PM-2.5
OAK	EDMS Aircraft Total	-4.24%	-6.89%	-7.31%	-8.28%	-8.71%	-8.71%
	EDMS APU Total	-5.69%	-6.18%	-6.26%	-6.60%	-6.58%	-6.58%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-4.26%	-6.88%	-7.27%	-8.18%	-8.17%	-8.17%
SFO	EDMS Aircraft Total	-22.40%	-20.24%	-7.02%	-15.24%	-16.68%	-16.68%
	EDMS APU Total	-3.38%	-3.54%	-3.63%	-3.69%	-3.48%	-3.48%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-22.10%	-20.17%	-6.93%	-14.85%	-14.78%	-14.78%
SJC	EDMS Aircraft Total	-6.90%	-10.41%	-14.81%	-14.10%	-15.12%	-15.12%
	EDMS APU Total	-7.36%	-8.78%	-11.82%	-11.18%	-10.19%	-10.19%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-6.92%	-10.38%	-14.67%	-13.89%	-13.68%	-13.68%

TABLE E-24. GREENHOUSE GAS EMISSIONS FOR HIGH SPEED RAIL (CASE 4).

Greenhouse Gases											
			OAK	SFO	SJC				OAK	SFO	SJC
2035	CO2					2035	CO2e				
	(kg)	Aircraft	678,913,220	2,126,682,912	350,901,410		(kg)	Aircraft	686,132,400	2,152,343,889	354,584,977
		GSE	-	-	-			GSE	-	-	-
		APU	9,388,955	21,008,733	6,124,308			APU	9,460,395	21,168,586	6,170,907
Total			688,302,175	2,147,691,645	357,025,718	Total			695,592,795	2,173,512,476	360,755,884

TABLE-25. CHANGE IN CO2E EMISSIONS, HIGH SPEED RAIL (CASE 4) VERSUS 2035 BASELINE.

CO2e, 2035	OAK	SFO	SJC
Aircraft	-7.41%	-8.22%	-14.04%
GSE	n/a	n/a	n/a
APU	-6.60%	-3.69%	-11.18%
Total	-7.39%	-8.18%	-13.99%

TABLE E-26. GHG EMISSIONS PER PASSENGER MILE IN 2035 FROM THE BAY AREA TO THE SOUTHERN CALIFORNIA MARKET.

	CO2e Intensity (g/mi-passenger)		
	OAK	SFO	SJC
Aircraft			
Most Efficient Aircraft	156	152	180
Least Efficient Aircraft	218	212	253

TABLE E-27 GHG EMISSIONS PER PASSENGER MILE IN 2035 FOR HIGH SPEED RAIL (HSR) TRAVEL FROM THE BAY AREA TO SOUTHERN CALIFORNIA

Mode	Baseline Energy Mix*	33% renewable**	50% renewable***
HSR 175 mph top speed	52	45	29
HSR 220 mph top speed	68	58	37

*Current Baseline for CA based on CA Energy Commission 2008 Total System Power

** the remaining 67% to come from 39.1% natural gas, 15.6% coal, 12.3% nuclear

*** the remaining 50% to come from 29.2% natural gas, 8.5% coal, and 12.3% nuclear

Air Traffic Control Technology Scenario (Case 5)

ATC technology improvements primarily reduce emissions by reducing aircraft taxi delays. As shown below the use of ATC technology decreased emissions more so for CO and VOC and less so for NOx emissions (which are less associated with taxi delay). Because ATC did not affect taxi delay at SJC no changes were seen in emissions. Both OAK and SFO showed similar reductions in GHG emissions of 0.6 to 0.7%.

TABLE E-28. CRITERIA POLLUTANT EMISSIONS FOR ATC TECHNOLOGY (CASE 5).

			Criteria Air Pollutants					
			CO (kg)	VOC (kg)	NOx (kg)	SOx (kg)	PM-10 (kg)	PM-2.5 (kg)
2035	OAK	EDMS Aircraft Total	1,838,054	194,011	1,342,835	112,922	15,951	15,951
		EDMS APU Total	37,230	2,985	50,728	6,930	5,471	5,471
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	1,875,284	196,995	1,393,563	119,853	21,423	21,423
	SFO	EDMS Aircraft Total	5,538,315	1,698,732	4,136,836	415,054	75,883	75,883
		EDMS APU Total	89,181	6,873	115,800	15,039	13,039	13,039
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	5,627,496	1,705,605	4,252,636	430,094	88,922	88,922
	SJC	EDMS Aircraft Total	739,329	99,798	716,741	63,204	9,300	9,300
		EDMS APU Total	27,852	2,024	35,467	4,754	3,843	3,843
		EDMS GSE Total	-	-	-	-	-	-
		Total, All	767,182	101,821	752,207	67,958	13,143	13,143

TABLE E-29. CHANGE IN CRITERIA POLLUTANT EMISSIONS, ATC TECHNOLOGY (CASE 5) VERSUS 2035 BASELINE.

Criteria Pollutants, 2035		CO	VOC	NOx	SOx	PM-1	PM-2
OAK	EDMS Aircraft Total	-2.02%	-2.91%	-0.47%	-1.60%	-1.64%	-1.64%
	EDMS APU Total	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-1.98%	-2.87%	-0.45%	-1.51%	-1.23%	-1.23%
SFO	EDMS Aircraft Total	-3.41%	-3.27%	-0.72%	-2.03%	-2.32%	-2.32%
	EDMS APU Total	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-3.36%	-3.26%	-0.70%	-1.96%	-1.98%	-1.98%
SJC	EDMS Aircraft Total	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	EDMS APU Total	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

TABLE E-30. GREENHOUSE GAS EMISSIONS FOR ATC TECHNOLOGY (CASE 5).

Greenhouse Gases											
			OAK	SFO	SJC				OAK	SFO	SJC
2035	CO2	Aircr				2035	CO2e	Aircr			
	(kg)	aft	728,747,290	2,299,625,252	408,226,080		(kg)	aft	736,469,366	2,327,835,106	412,492,162
		GSE	-	-	-			GSE	-	-	-
		APU	10,052,259	21,814,080	6,895,172			APU	10,128,746	21,980,061	6,947,637
Total			738,799,549	2,321,439,331	415,121,253	Total			746,598,112	2,349,815,167	419,439,799

TABLE E-31. CHANGE IN CO2E EMISSIONS, ATC TECHNOLOGY (CASE 5) VERSUS 2035 BASELINE.

CO2e, 2035	OAK	SFO	SJC
Aircraft	-0.61%	-0.74%	0.00%
GSE	n/a	n/a	n/a
APU	0.00%	0.00%	0.00%
Total	-0.60%	-0.73%	0.00%

Demand Management Scenario (Case 6)

The Demand Management Scenario (Case 6) results in a decrease in emissions due to the decrease in taxi delay at SFO. The Demand management Scenario only assumes that demand management is implemented at SFO, therefore there are no changes in emissions relative to the future base case for OAK or SJC. Criteria pollutant emission reductions at SFO are largest for VOC and CO and smallest for NO_x. GHG emission reductions are relatively modest at just 2.4%.

TABLE E-32. CRITERIA POLLUTANT EMISSIONS FOR DEMAND MANAGEMENT (CASE 6).

		Criteria Air Pollutants					
		CO (kg)	VOC (kg)	NOx (kg)	SOx (kg)	PM-10 (kg)	PM-2.5 (kg)
SFO	EDMS Aircraft Total	4,673,761	1,447,885	4,022,065	378,488	67,431	67,431
	EDMS APU Total	83,745	6,571	114,059	14,742	12,634	12,634
	EDMS GSE Total	-	-	-	-	-	-
	Total, All	4,757,506	1,454,456	4,136,124	393,230	80,065	80,065

TABLE E-33. CHANGE IN CRITERIA POLLUTANT EMISSIONS, DEMAND MANAGEMENT (CASE 6) VERSUS 2035 BASELINE.

Criteria Pollutants, 2035		CO	VOC	NOx	SOx	PM-10	PM-2.5
SFO	EDMS Aircraft Total	-18.49%	-17.55%	-3.47%	-10.66%	-13.20%	-13.20%
	EDMS APU Total	-6.10%	-4.39%	-1.50%	-1.97%	-3.11%	-3.11%
	EDMS GSE Total	n/a	n/a	n/a	n/a	n/a	n/a
	Total, All	-18.30%	-17.50%	-3.42%	-10.36%	-11.75%	-11.75%

TABLE E-34. GREENHOUSE GAS EMISSIONS FOR DEMAND MANAGEMENT (CASE 6).

SFO				SFO			
2035	CO ₂	Aircraft	2,262,215,506	2035	CO _{2e}	Aircraft	2,289,508,899
		GSE	-			GSE	-
		APU	21,383,476			APU	21,546,181
Total			2,283,598,982	Total			2,311,055,080

TABLE E-35. CHANGE IN CO_{2e} EMISSIONS, DEMAND MANAGEMENT (CASE 6) VERSUS 2035 BASELINE.

CO _{2e} , 2035	SFO
Aircraft	-2.4%
APU	-2.0%
Total	-2.4%

Continuous Descent Approach (Case 7)

Greenhouse gas emissions under the Continuous Descent Approach (CDA) scenario (Case7) are reduced from those under the 2035 Baseline scenario (Case0b) due to a reduction in fuel use during aircraft approach. The approach patterns for CDA and conventional approach are identical between 2,300 ft and landing, but GHG emissions are reduced over the longer flight paths considered in this analysis. However, the CDA approach only contributes a relatively small fraction of the total GHG emissions with taxi-in, taxi-out, climb-out and takeoff making up the majority (88-92%) of the GHG emissions. Thus the overall greenhouse gas emissions are only reduced (measured in kg CO_{2e}) between 1-3%. The greatest percentage reductions for GHG emissions are seen at OAK (2.5%), but the largest emission reductions (44.8 million kg CO_{2e}) occur at SFO. Nearly all (~99%) of these emission changes are due to reductions in CO₂ emissions. Table E-36 shows the actual and relative GHG emissions for CDA.

TABLE E-36. GREENHOUSE GAS EMISSIONS FOR CONTINUOUS DESCENT APPROACH (CASE 7).

		CDA Change from Future Baseline	Greenhouse Gases (kg CO2e)				Change from Baseline
			Future Baseline Approach	All Other Future Baseline	Total Future Baseline	CDA	
OAK							
Aircraft	CO2	(24.2%)	75,635,084	657,589,758	733,224,842	714,921,151	-2.5%
	CH4	8.5%	140,852	752,042	892,894	904,866	
	N2O	(24.2%)	710,730	6,179,256	6,889,986	6,717,989	
	CO2e	-	76,486,665	664,521,056	741,007,721	722,544,007	
APU	CO2	(24.2%)	-	10,052,259	10,052,259	10,052,259	0.0%
	CH4	8.5%	-	11,675	11,675	11,675	
	N2O	(24.2%)	-	64,812	64,812	64,812	
	CO2e	-	-	10,128,746	10,128,746	10,128,746	
Total	CO2e		76,486,665	674,649,802	751,136,467	732,672,752	-2.5%
SFO							
Aircraft	CO2	(24.2%)	183,592,078	2,132,999,687	2,316,591,765	2,272,162,482	-1.9%
	CH4	8.5%	511,574	6,243,960	6,755,534	6,799,018	
	N2O	(24.2%)	1,725,183	20,043,426	21,768,608	21,351,114	
	CO2e	-	185,828,834	2,159,287,073	2,345,115,907	2,300,312,614	
APU	CO2	(24.2%)	-	21,814,080	21,814,080	21,814,080	0.0%
	CH4	8.5%	-	25,335	25,335	25,335	
	N2O	(24.2%)	-	140,647	140,647	140,647	
	CO2e	-	-	21,980,061	21,980,061	21,980,061	
Total	CO2e		185,828,834	2,181,267,134	2,367,095,968	2,322,292,675	-1.8%
SJC							
Aircraft	CO2	(24.2%)	39,778,762	368,447,318	408,226,080	398,599,620	-2.4%
	CH4	8.5%	56,699	373,354	430,053	434,872	
	N2O	(24.2%)	373,794	3,462,235	3,836,029	3,745,571	
	CO2e	-	40,209,255	372,282,908	412,492,162	402,780,063	
APU	CO2	(24.2%)	-	6,895,172	6,895,172	6,895,172	0.0%
	CH4	8.5%	-	8,008	8,008	8,008	
	N2O	(24.2%)	-	44,457	44,457	44,457	
	CO2e	-	-	6,947,637	6,947,637	6,947,637	
Total	CO2e		40,209,255	379,230,545	419,439,799	409,727,700	-2.3%



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BAY AREA FORECAST TRACKING SYSTEM RECOMMENDATIONS

Prepared for:

Regional Airport Planning Committee



Prepared by:

SH&E
an ICF International Company

June 3, 2011

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1 OBJECTIVE

There is always a degree of uncertainty inherent in any long-term aviation demand forecast and more so when the forecast is prepared during a time of economic instability and structural changes in the airline industry. In recognition of this, the update to the Regional Airport System Plan Analysis includes recommendations for a forecast tracking system that can be used to gauge how well the forecasts are tracking against actual airport activity at the primary Bay Area airports. With this information, RAPC can adjust its policies and recommendations for the region's airports and make any necessary forecast adjustments between major study updates.

2 FORECAST TRACKING SYSTEM FRAMEWORK

The forecast tracking system must assist RAPC planners in answering the following questions:

- How do actual airport traffic levels compare to the forecast traffic levels?
- What is driving the difference between actual and forecasts traffic levels?
- Is the variance from the forecasts significant enough to warrant a forecast adjustment or update?

Ultimately, the answers to these questions will determine policy recommendations and actions (or inactions) that will allow the region's airports to meet future air travel demand. To be useful and effective, the system must not be overly complex or redundant. In designing the system consideration was given to the fact that it will be carried out by RAPC staff with limited resources and access to aviation databases. The recommended tracking metrics are mostly based on public data sources available from the airports and government agencies.

3 FORECAST TRACKING SYSTEM METRICS

3.1 HOW DO ACTUAL AIRPORT TRAFFIC LEVELS COMPARE TO THE FORECAST?

The basic metrics that should be tracked to determine how the forecasts compare to actual traffic are passengers and aircraft operations. The most important of these metrics is airport passengers, since this is the main driver of aircraft operations and runway demand. Explicitly tracking aircraft operations is also essential because it is the main determinant of airside delays and it will feed directly into a Congestion Tracking System, designed to monitor airside congestion and delays. Cargo activity can also be tracked

and measured against the forecast, but cargo is not a significant contributor to airside delays and congestion. More than 20 percent of cargo is carried in the belly compartments of passenger aircraft, the volume of all-cargo flights is low compared to passenger aircraft flights (only 5 percent of total operations were all-cargo in 2007), and most all-cargo aircraft flights occur during off-peak times.

3.1.1 Airport Passengers

Total Airport Passengers – Bay Area and by Airport

Total airport passengers by airport can be tracked using data reported by the airports that is available from their websites. Exhibit 1 shows how total system passengers can be tracked against forecast passengers for each of the scenarios for an illustrative year, 2015. The comparison can also be shown graphically as a double bar chart showing actual traffic and Base Case forecast traffic for each year from 2011 to the most recent actual period. In the example shown for 2015, total passenger demand for the Bay Area airports is running 1.3 percent below the Base Case forecast. 2.8 percent above the Low Case and 7.4 percent below the High Case. Comparisons should not be made before 2011, since passenger traffic was declining due to the economic recession and oil price shocks at the time that the forecasts were prepared. The appropriate starting year for annual comparisons is 2011 because the forecast assumed that Bay Area traffic levels would recover to the previous (2007) level in that year.

Exhibit 1: Illustrative Comparison of Actual and Forecast System Total Passengers (OAK, SFO and SJC), 2015

Year	Actual	Forecast			Actual vs. Forecast		
		Base	Low	High	Base	Low	High
2007	60,592,224						
2008	58,258,902						
2009	55,051,281						
2010	57,025,829						
2011	58,801,374	60,592,224	60,592,224	60,592,224	0.970	0.970	0.970
2012	59,023,594	62,060,722	61,423,312	63,057,712	0.951	0.961	0.936
2013	60,794,302	63,568,185	62,269,905	65,625,626	0.956	0.976	0.926
2014	64,077,194	65,115,703	63,132,305	68,300,292	0.984	1.015	0.938
2015	65,807,278	66,704,398	64,010,823	71,086,226	0.987	1.028	0.926
2016		68,335,424	64,905,776	73,988,133	-	-	-
2017		70,009,969	65,817,485	77,010,923	-	-	-
2018		71,729,255	66,746,280	80,159,714	-	-	-
2019		73,494,539	67,692,497	83,439,846	-	-	-
2020		75,307,115	68,656,477	86,856,888	-	-	-
2021		76,806,138	69,811,737	89,161,950	-	-	-
2022		78,335,773	70,986,917	91,528,882	-	-	-
2023		79,896,660	72,182,367	93,959,363	-	-	-
2024		81,489,451	73,398,445	96,455,116	-	-	-
2025		83,114,812	74,635,514	99,017,913	-	-	-
2026		84,773,425	75,893,943	101,649,574	-	-	-
2027		86,465,984	77,174,110	104,351,968	-	-	-
2028		88,193,199	78,476,397	107,127,016	-	-	-
2029		89,955,796	79,801,195	109,976,691	-	-	-
2030		91,754,514	81,148,901	112,903,022	-	-	-
2031		93,590,110	82,519,919	115,908,091	-	-	-
2032		95,463,357	83,914,662	118,994,039	-	-	-
2033		97,375,042	85,333,547	122,163,065	-	-	-
2034		99,325,972	86,777,001	125,417,429	-	-	-
2035		101,316,970	88,245,459	128,759,451	-	-	-
AAG							
2007-2015	1.0%	1.2%	0.7%	2.0%			
2011-2020		2.4%	1.4%	4.1%			
2020-2035		2.0%	1.7%	2.7%			

Notes: 2007 is the forecast Base Year.
Data for 2011 to 2015 are illustrative.
Actual data for 2008 to 2010 are from statistics published on the airport websites.

The illustrative example in Exhibit 2 compares actual passengers by airport to forecast passengers for the Baseline (using the Base Case forecast) and Scenario B, the preferred scenario. This comparison provides an indication of how well the individual airports are tracking against the forecasts, and the degree of traffic redistribution that has been achieved. In this example, SFO is tracking well ahead of the Baseline and Scenario B forecasts, while OAK and SJC are tracking lower than forecast, an indication

that traffic redistribution is not occurring. In this example, airport passenger traffic is becoming more concentrated at SFO, which would signal the need to implement demand management or other policies to encourage traffic redistribution. These comparisons could also be shown graphically. A bar chart similar to the one described for total Bay Area passengers can be used to show the actual versus forecast trend for each individual airport. Pie charts can be used to compare the current distribution by airport to the forecast distributions in the Base Case and Scenario B.

Exhibit 2: Illustrative Comparison of Actual and Forecast Passengers by Airport, 2015

Year	Passengers				Change Over Prior year				Share of Total		
	OAK	SFO	SJC	Total	OAK	SFO	SJC	Total	OAK	SFO	SJC
Actual											
2007	14,616,594	35,317,241	10,658,389	60,592,224	-	-	-	-	24%	58%	18%
2008	11,474,456	37,066,729	9,717,717	58,258,902	-21.5%	5.0%	-8.8%	-3.9%	20%	64%	17%
2009	9,505,281	37,224,250	8,321,750	55,051,281	-17.2%	0.4%	-14.4%	-5.5%	17%	68%	15%
2010	9,542,333	39,234,360	8,249,136	57,025,829	0.4%	5.4%	-0.9%	3.6%	17%	69%	14%
2011	10,416,444	39,679,990	8,704,940	58,801,374	9.2%	1.1%	5.5%	3.1%	18%	67%	15%
2012	10,455,809	39,829,948	8,737,838	59,023,594	0.4%	0.4%	0.4%	0.4%	18%	67%	15%
2013	10,769,483	41,024,846	8,999,973	60,794,302	3.0%	3.0%	3.0%	3.0%	18%	67%	15%
2014	11,351,035	43,240,188	9,485,971	64,077,194	5.4%	5.4%	5.4%	5.4%	18%	67%	15%
2015	11,657,513	44,407,673	9,742,092	65,807,278	2.7%	2.7%	2.7%	2.7%	18%	67%	15%
AAG 2007-15	-2.8%	2.9%	-1.1%	1.0%							
Forecast - Baseline											
Base Case											
2020	16,332,161	46,124,417	12,850,537	75,307,115					22%	61%	17%
2035	20,655,297	64,356,302	16,305,371	101,316,970					20%	64%	16%
AAG 2007-35	1.2%	2.2%	1.5%	1.9%							
Forecast - Scenario B											
2035	24,080,125	56,312,929	20,042,065	100,435,119					24%	56%	20%
AAG 2007-35	1.8%	1.7%	2.3%	1.8%							

Notes: 2007 is the forecast Base Year.
Data for 2011 to 2015 are illustrative.
Actual data for 2008 to 2010 are from statistics published on the airport websites.

International Airport Passengers - SFO

Actual growth in international airport passengers can also be measured against the forecast. Activity statistics provided by SFO provide a breakout of domestic and international passengers at the airport. Since SFO accounts for 97 percent of total international passenger traffic at the Bay Area airports, tracking actual international traffic against the forecast international traffic for SFO would be sufficient for understanding how much of the difference between actual and forecast passengers is due to changes in the underlying growth assumptions for international passenger demand. The comparison could be shown

graphically with a double bar chart of actual versus Base Case forecast passengers for each year from 2011 to the most recent actual period.

Data Sources

Aggregate passenger data can be obtained from the airport operators. All three airports regularly post airport traffic data on their websites. Current links to these data sources are summarized below:

OAK: http://www.flyoakland.com/airport_stats_monthly_report.shtml

SFO: <http://www.flysfo.com/web/page/about/news/pressres/stats-2009.html>

SJC: <http://www.flysanjose.com/about.php?page=activity/activity&exp=3&subtitle=Activity+and+Financials+|+Airport+Activity>

3.1.2 Aircraft Operations

The most appropriate comparison for tracking aircraft operations is by individual airport. As shown in Exhibit 3, a comparison for the example year, 2015, shows that aircraft operations at SFO are increasing slightly faster than the baseline forecast growth rate, but significantly faster than the Scenario B forecast growth rate. The sample analysis also indicates that operations, like passengers, are well below the forecast levels for OAK and SJC.

Exhibit 3: Illustrative Comparison of Actual and Forecast Aircraft Operations by Airport, 2015

Year	OAK		SFO		SJC	
	Aircraft Operations	Annual Change	Aircraft Operations	Annual Change	Aircraft Operations	Annual Change
Actual						
2007	337,295	-	373,015	-	199,742	-
2008	269,631	-20.1%	387,710	3.9%	172,576	-13.6%
2009	233,183	-13.5%	379,751	-2.1%	145,838	-15.5%
2010	219,652	-5.8%	387,346	2.0%	123,490	-15.3%
2011	220,080	0.2%	389,546	0.6%	126,902	2.8%
2012	230,160	4.6%	390,282	0.2%	127,141	0.2%
2013	230,595	0.2%	396,136	1.5%	129,049	1.5%
2014	234,054	1.5%	406,832	2.7%	132,533	2.7%
2015	240,373	2.7%	412,324	1.4%	134,322	1.4%
AAG 2007-YTD		-4.1%		1.3%		-4.8%
Forecast - Baseline						
Base Case						
2020	301,091		431,172		202,556	
2035	354,945		526,595		242,739	
AAG 2007-2035		0.2%		1.2%		0.7%
Forecast - Scenario B						
2035	386,937		441,070		277,796	
AAG 2007-2035		0.5%		0.6%		1.2%

Notes: 2007 is the forecast Base Year.
 Data for 2011 to 2015 are illustrative.
 Actual data for 2008 to 2010 are from statistics published on the airport websites.

Since it is important for RAPC to understand when the airports may reach their capacity limits, it would be useful to track not only total aircraft operations, but also aircraft operations by type of operator. The forecasts are further broken down by type of operations with separate projections for passenger airlines, all-cargo airlines, itinerant general aviation-jets, itinerant general aviation-non jets, local general aviation and the military. However, for actual aircraft operation counts the individual airports report less detail, making a comparison to the forecast by type of operation difficult. In recent reports, SJC provides adequate detail to track the main types: passenger, all-cargo, itinerant GA, local GA and military. SFO reports Air Carrier (i.e., passenger airlines that operate aircraft with 60 or more seats), Air Taxi, which includes small regional carriers with a fleet of aircraft that have fewer than 60 seats, as well as on-demand operators, Civil (i.e., general aviation) and military. However, GA operations as defined in the study (i.e., private GA aircraft operations and air taxi or charter operations conducted with GA aircraft) differ from the “GA” operations data reported by SFO. The data reported as GA by SFO excludes some air taxi

operations which are instead combined with regional/commuter airline operations. OAK's activity report published online only reports total aircraft operations with no breakdown by type.

Exhibit 4 shows actual aircraft operations for each airport by user category as reported by the FAA. Like the airport published statistics, which are based on the FAA Tower counts, the operations are grouped differently than how they were grouped in the forecasts. The operations reported as "Air Taxi" by the FAA include some operations by regional/commuter airlines in addition to operations by air taxi operators. As shown, in Exhibit 4, because of this discrepancy between the reporting categories for actual operations and the forecast categories, it is difficult to monitor how actual airline operations compare to forecast aircraft operations. The FAA's "Air Taxi" category includes some commercial airline activity so the operations reported as "Airline" actually understate the true level of operations by commercial airlines. Similarly, the "Air Taxi" counts include some types of activity (e.g., private charter flights provided by fractional jet operators such as NetJets) that were grouped with itinerant General Aviation in the forecasts. Therefore, the FAA's "Itinerant GA" counts cannot be directly compared to the forecasts of itinerant GA operations.

Exhibit 4: Comparison of Actual FAA Operation Counts and Forecast Aircraft Operations by Airport and Operator Type

Year	Itinerant Operations				Local Operations		
	Airline	Air Taxi	GA	Military	Civil	Military	Total
OAK							
Actual \1							
2007	175,305	31,024	59,689	274	81,332	122	347,746
2008	148,973	28,229	49,127	696	46,031	1,214	274,270
2009	118,918	22,411	43,983	1,306	45,025	2,978	234,621
2010	112,493	23,448	42,658	1,511	36,591	2,949	219,650
Forecast - Baseline							
Base Case							
2020	195,408		59,256	274	46,031	122	301,091
2035	233,091		71,883	274	49,575	122	354,945
Forecast - Scenario B							
2035	265,083		71,883	274	49,575	122	386,937
SFO							
Actual \1							
2007	262,135	95,582	19,149	2,634	68	0	379,568
2008	284,350	85,470	15,453	2,697	134	0	388,104
2009	279,864	84,378	13,030	3,039	0	0	380,311
2010	287,959	83,931	13,586	3,282	0	0	388,758
Forecast - Baseline							
Base Case							
2020	396,574		31,901	2,697	0	0	431,172
2035	480,126		43,772	2,697	0	0	526,595
Forecast - Scenario B							
2035	404,178		34,195	2,697	0	0	441,070
SJC							
Actual \1							
2007	122,987	29,408	40,019	82	15,682	18	208,196
2008	113,560	24,750	37,065	134	15,555	72	191,136
2009	89,654	27,603	26,558	357	14,300	17	158,489
2010	84,494	22,657	26,336	273	4,538	2	138,300
Forecast - Baseline							
Base Case							
2020	132,707		54,272	82	15,477	18	202,556
2035	156,772		69,198	82	16,669	18	242,739
Forecast - Scenario B							
2035	191,829		69,198	82	16,669	18	277,796

\1 Actual operations are from the FAA ATADS database. Totals may differ from totals reported by airports and from the forecast base year totals for 2007.

Note: "Air Taxi" counts reported by FAA include some regional/commuter airline operations and some general aviation air taxi operations.

Therefore, if RAPC wishes to track aircraft operations by type, it will need to work with the airports to obtain disaggregate operations data that can be used to construct operations in a manner that is consistent with the study definitions.

If RAPC can obtain the disaggregate data directly from the airport, the comparison of actual and forecast activity could be depicted in a double stacked bar chart that shows actual and forecast operations for each year with each bar showing divisions for the two categories: airline operations and GA operations.

Data Sources

Each airport reports total aircraft operations in the same online activity reports used for passenger traffic counts, as described above.

The FAA's operations counts for the airports can be obtained from the FAA's Air Traffic Activity Data System (ATADS) through the following link:

FAA ATADS: <http://aspm.faa.gov/opsnet/sys/Main.asp?force=atads>

3.1.3 Air Cargo Volumes

The cargo projections can be tracked against actual air cargo volumes for the three-airport system as well as for each airport individually. Exhibit 5 shows how actual system-wide cargo can be tracked against forecast cargo for an illustrative year, 2015. In this example, air cargo tons for the region remain 16-22 percent below the forecasts. Exhibit 6 compares actual to forecast air cargo tons for each airport individually. In this example, cargo volumes at each of the airports are lower than the projected volumes in 2015. Note that a separate cargo forecast was not prepared for the Scenario B alternative. The comparisons can be made graphically using a double bar chart showing actual and forecast cargo volumes for each year. In the forecasts, total cargo volumes were projected without a separate breakout of mail and air freight.

Exhibit 5 – Illustrative Comparison of Actual and Forecast System Cargo Tons (OAK, SFO, and SJC), 2015

Year	Actual	Forecast			Actual vs. Forecast		
		Base	Low	High	Base	Low	High
2007	1,425,818						
2008	1,311,142						
2009	1,050,824						
2010	1,083,082						
2011	1,115,575	1,425,818	1,425,818	1,425,818	0.782	0.782	0.782
2012	1,165,776	1,463,626	1,450,858	1,476,560	0.796	0.804	0.790
2013	1,208,909	1,502,437	1,476,337	1,529,108	0.805	0.819	0.791
2014	1,247,594	1,542,277	1,502,264	1,583,526	0.809	0.830	0.788
2015	1,285,022	1,583,173	1,528,646	1,639,881	0.812	0.841	0.784
2016		1,625,153	1,555,491	1,698,241			
2017		1,668,247	1,582,808	1,758,678			
2018		1,712,483	1,610,605	1,821,266			
2019		1,757,893	1,638,890	1,886,081			
2020		1,804,506	1,667,671	1,953,203			
2021		1,855,438	1,698,191	2,028,779			
2022		1,907,808	1,729,270	2,107,280			
2023		1,961,655	1,760,918	2,188,819			
2024		2,017,023	1,793,145	2,273,512			
2025		2,073,953	1,825,962	2,361,483			
2026		2,132,490	1,859,379	2,452,857			
2027		2,192,679	1,893,408	2,547,767			
2028		2,254,567	1,928,060	2,646,350			
2029		2,318,202	1,963,346	2,748,747			
2030		2,383,633	1,999,278	2,855,106			
2031		2,450,910	2,035,867	2,965,581			
2032		2,520,087	2,073,126	3,080,330			
2033		2,591,216	2,111,066	3,199,519			
2034		2,664,353	2,149,702	3,323,321			
2035		2,739,554	2,189,044	3,451,912			
AAG							
2007-2010	-8.8%						
2011-2020		2.7%	1.8%	3.6%			
2020-2035		2.8%	1.8%	3.9%			

Note: Includes freight and mail.
Data for 2011-2015 are illustrative.

Exhibit 6 – Illustrative Comparison of Actual and Forecast Cargo Tons by Airport, 2015

Year	OAK		SFO		SJC	
	Cargo Tons	Annual Change	Cargo Tons	Annual Change	Cargo Tons	Annual Change
Actual						
2007	713,866	-	620,527	-	91,426	-
2008	685,789	-3.9%	544,132	-12.3%	81,222	-11.2%
2009	541,497	-21.0%	449,855	-17.3%	59,471	-26.8%
2010	563,337	4.0%	470,383	4.6%	49,363	-17.0%
2011	583,498	3.6%	462,970	-1.6%	69,107	40.0%
2012	600,733	3.0%	499,066	7.8%	65,977	-4.5%
2013	628,783	4.7%	525,029	5.2%	55,097	-16.5%
2014	652,550	3.8%	517,759	-1.4%	77,286	40.3%
2015	662,181	1.5%	550,115	6.2%	72,726	-5.9%
AAG 2007-YTD		-0.9%		-1.5%		-2.8%
Forecast - Baseline						
Base Case						
2020	861,605		832,921		109,980	
2035	1,179,177		1,410,614		149,762	
AAG 2007-2035		1.8%		3.0%		1.8%

Note: Includes freight and mail.
Data for 2011-2015 are illustrative.

Data Sources

The annual cargo volumes can be obtained from each airport's published monthly statistics report.

3.1.4 Benchmarking Against Other Forecasts

RAPC may also wish to benchmark the planning forecasts against other publicly available forecasts. The FAA produces airport level forecasts annually as well as projections for the overall U.S. aviation market. In the *Terminal Area Forecasts (TAF)*, the FAA forecasts passenger and aircraft operations activity for individual airports in the national air transportation network. The forecasts of passengers by airport can easily be compared to the FAA's combined forecasts for air carrier and air taxi/commuter passengers. In terms of aircraft operations, the forecast operations in the TAF are reported for the same categories that are tracked in the ATADS. Therefore, if RAPC wishes to benchmark forecast operations by subcategory the best method would be to benchmark growth rates as described in Section 3.1.2.

The FAA also publishes its industry-wide *Aerospace Forecasts* annually. RAPC can assess the state of the U.S. industry and the near-term and long-term outlook for the industry by reviewing the FAA's annual projections. RAPC could specifically track the FAA's forecast growth rates for:

- Domestic passengers (U.S. Commercial Air Carrier domestic enplanements in Table 5)
- International passengers, total and by world region (U.S. and Foreign Flag Carrier enplanements in Table 8)
- Airline Operations (sum of Air Carrier and Air Taxi/Commuter operations in Table 31)
- Itinerant General Aviation Operations (Table 31)
- Local General Aviation Operations (Table 31)

Data Sources

The FAA Terminal Area Forecast is typically released in December and can be accessed at the following link:

FAA TAF: <http://aspm.faa.gov/main/taf.asp>

The FAA Aerospace Forecast is typically published during February or March of each year and can be obtained through the web link provided:

FAA Aerospace Forecast:

http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/

3.2 WHAT IS DRIVING THE VARIATION BETWEEN ACTUAL AND FORECAST AIRPORT TRAFFIC LEVELS?

The forecasts of regional passenger demand reflect several assumptions regarding the primary drivers of air travel demand such as economic growth, air fares, and fuel prices which are reflected in air fares, as well as other variables. Actual changes in these variables compared to the baseline forecast assumptions are one source of variation between actual and forecast activity levels. One objective of the tracking system is to determine the extent to which variance in traffic growth for the region as a whole is explained by variation in the forecast drivers. If the variance in regional demand compared to the forecast can not be explained by differences in the assumed values for the underlying drivers, other factors not explicitly included in the forecast model may be causing some or all of the unexplained traffic variation.

The main metrics to assess differences between actual and forecast values for the underlying drivers of demand are: real personal income for the Bay Area, average passenger fares, the price of oil, and U.S.-international air passenger traffic.

3.2.1 Personal Income

The forecast model for domestic local passengers, which account for over 70 percent of passengers at the primary Bay Area airports, incorporated real personal income for the Bay Area as an indicator of economic growth. Real personal income is equivalent to population times inflation-adjusted income per capita and is a measure of the region's population and income levels. Forecast values for real personal income were based on ABAG's 2007 Projections. Tracking actual personal income for the 9-county Bay Area against the forecast assumptions will provide an indication of whether or not economic changes are responsible for observed differences between actual and forecast traffic levels.

Data Sources

Actual values for Bay Area personal income can be obtained from ABAG or directly from the U.S. Department of Commerce, Bureau of Economic Analysis at the link provided below.

BEA Local Area Personal Income, Interactive Database: <http://www.bea.gov/regional/reis/default.cfm?selTable=CA1-3§ion=2>

The forecast values are expressed in constant 2000 dollars. Adjustments to nominal personal income can be made using the Consumer Price Index – All Urban Consumers (CPI-U) from the U.S. Department of Labor, Bureau of Labor Statistics.

BLS Consumer Price Index (CPI-U): <http://www.bls.gov/cpi/tables.htm>

3.2.2 Other Measures of Underlying Economic Growth

Another easily obtainable measure of economic growth, which is correlated with Bay Area personal income, is U.S. Gross Domestic Product. While the growth rate for actual U.S. GDP is not directly comparable to the forecast growth assumptions for Bay Area personal income, there is an advantage to tracking this variable as well as personal income. GDP statistics are released on a more timely basis than local personal income statistics and would be an indication of how Bay Area personal income may be growing relative to the forecast growth rate assumptions. It should be noted that year-to-year statistics for personal income and U.S. GDP will reflect actual fluctuations in the business cycle, whereas the forecast for personal income was based on a long-term average growth rate assumption and did not consider cyclical variations.

Data Sources

Actual values for real U.S. GDP can be obtained from the U.S. Bureau of Economic Analysis at the following link:

BEA National Economic Accounts Data: <http://www.bea.gov/index.htm>

3.2.3 Airline Yields and Airfares

Average Yield in Bay Area Top O&D Markets

In the forecast model, the price of air travel was based on the real average airline yield (i.e., the airlines' average revenue per passenger mile adjusted for inflation) for the Bay Area's 50 largest domestic O&D markets in 2006. To avoid distortions in the yield trend over time (due to changes in the mix of destinations and average stage length), the average yield for each year was determined using a constant distribution of passengers by O&D market. Evaluating changes in actual average airline yield for these markets against the forecast yield values will indicate the extent to which variations in airline pricing have contributed to air traffic variations.

Average U.S. Airline Industry Domestic Yield

RAPC may wish to track the average trend in U.S. airline yields for domestic markets to gauge the underlying trend in airline yields in the industry. These data can be easily obtained from the Air Transport Association, which represents major U.S. airlines. However, because of differences in the mix of airlines and destinations serving the Bay Area, the change in average domestic yield for the U.S. industry may differ from the change in actual Bay Area yields, and specifically the market weighted average Bay Area yield used to forecast Bay Area passenger demand. While the long-term trend for the average U.S. industry yield is similar to the long-term trend in the Bay Area yield variable used in the forecast, there are differences in the year-to-year variations.

Data Sources and Computation

The average yield metric can be computed from airline ticket data reported in the U.S. DOT, Airline Origin-Destination Survey (DB1B) for each of the primary Bay Area Airport to 50 top destination markets using the fixed market weights used in the forecast analysis (See Exhibit 7). The U.S. DOT O&D Survey data required to calculate the real average yield measure for the Bay Area can be downloaded from the Research and Innovative Technology Administration (RITA) of the Bureau of Transportation Statistics. Passengers, fare and miles flown for the Bay Area airports can be summed for each of the 50 O&D markets to calculate an average Bay Area yield for each market. The 50 average market yields can then be averaged using the market weights provided in Exhibit 4 to calculate the nominal weighted average yield for each year. The weighted average nominal yield can then be expressed in real terms (in constant 2000 dollars) using the CPI-U as described for real personal income. The same data can be used

to calculate the average passenger fares in the top destination markets for each of the Bay Area airports. To obtain the data RAPC will need to select the download option for the state of California, which will return passengers, fare and miles flown data for individual passenger itineraries with a California airport as an origin or destination. The data returned will be too large to work with in MS Excel and will need to be processed and summarized with a database application such as MS Access.

**Airline Origin-Destination
Survey DB1B Market Data:**

http://www.transtats.bts.gov/Tables.asp?DB_ID=125&DB_Name=Airline%20Origin%20and%20Destination%20Survey%20%28DB1B%29&DB_Short_Name=Origin%20and%20Destination%20Survey

The average domestic yield for U.S. Airlines can be obtained from the Air Transport Association website at the link provided below. The ATA reports yields in both nominal and real terms.

Average U.S. Domestic Airline Yield:

<http://www.airlines.org/Economics/DataAnalysis/Pages/AnnualPassengerYieldUSAirlines.aspx>

Exhibit 7 - Top 50 Bay Area O&D Markets and Market Weights

Rank	Market	Market Weight	Rank	Market	Market Weight
1	Los Angeles	10.0%	26	Orlando	1.1%
2	New York	7.5%	27	Baltimore	0.9%
3	San Diego	6.9%	28	Reno	0.9%
4	Las Vegas	4.6%	29	Albuquerque	0.9%
5	Seattle	4.6%	30	Miami	0.9%
6	Orange County	4.9%	31	Kansas City	0.8%
7	Burbank	5.1%	32	Saint Louis	0.8%
8	Chicago	4.1%	33	Fort Lauderdale	0.6%
9	Phoenix	3.8%	34	Raleigh/Durham	0.5%
10	Portland	2.9%	35	Tampa	0.6%
11	Boston	3.0%	36	Charlotte	0.5%
12	Washington	3.1%	37	Kona	0.5%
13	Ontario	3.7%	38	Tucson	0.6%
14	Denver	2.8%	39	Indianapolis	0.5%
15	Honolulu	2.9%	40	Kauai	0.5%
16	Dallas/Fort Worth	2.2%	41	Boise	0.4%
17	Atlanta	1.7%	42	Cleveland	0.6%
18	Houston	1.7%	43	Pittsburgh	0.6%
19	Salt Lake City	1.4%	44	Spokane	0.4%
20	Philadelphia	1.6%	45	San Antonio	0.5%
21	Minneapolis	1.4%	46	Nashville	0.4%
22	Kahului	1.0%	47	Hartford	0.5%
23	Long Beach	1.4%	48	Palm Springs	0.5%
24	Detroit	1.2%	49	Milwaukee	0.4%
25	Austin	0.9%	50	New Orleans	0.5%

3.2.4 Oil Prices

Fuel prices are especially volatile and the forecasts assume that in the future, fuel prices will have the most bearing on airline yields. Whereas in the past, the expansion of low cost carriers (LCCs) has had the greatest impact on air fares, legacy carriers have greatly reduced their operating expenses through restructuring so that going forward LCCs are unlikely to exert as much downward pressure on airline yields as they have in the past. In the future, changes in the price of fuel, which now represents a significant portion of airline expenses (approximately 30 percent in 2010), will be a primary driver of air fares and passenger demand. Airline yield assumptions in the forecast model were explicitly linked to the assumptions regarding future oil prices. Thus to understand the difference between actual and forecast passenger demand, it is necessary to also follow how actual fuel prices compare to the fuel price assumptions underlying the forecast.

Data Sources

The fuel metric used in the forecast was the spot price per barrel of Cushing, OK WTI crude oil. Annual prices for this petroleum product can be obtained from the U.S. Energy Information Administration (EIA). All forecast fuel prices were expressed in real terms based on 2007 dollars. Actual future prices of oil can be deflated to 2007 dollars using the CPI-U as described for yields and personal income.

**U.S. EIA Cushing, OK WTI
Crude Oil Prices:**

http://www.eia.doe.gov/dnav/pet/PET_PRI_SPT_S1_A.htm

The EIA also provides the price of jet fuel which may also be tracked.

Kerosene-Type Jet Fuel Prices:

http://www.eia.doe.gov/dnav/pet/pet_pri_refoth_dcu_nus_m.htm

3.2.5 U.S. International Passenger Traffic

International passengers defined as passengers on flights traveling to or from destinations outside the U.S., accounted for 15 percent of total passengers at the Bay Area airports in 2007. The forecast of domestic O&D passengers was based on an econometric approach that related changes in passenger demand to changes in airline yields and personal income. However, because SFO is a major international connecting gateway that serves passengers from across the U.S. and abroad, international passenger demand was forecast based on SFO's assumed share of future U.S.-international air passenger traffic. Thus, differences in actual and projected U.S.-international passengers could explain observed differences between actual and forecast Bay Area passengers. While SFO's share of U.S. international traffic was slightly increased over the forecast period for some world regions (i.e., Australia and Mexico), as a mature gateway, SFO's share for most world regions was held constant over the forecast horizon. To fully understand the difference between actual and forecast international passenger demand, RAPC may wish

to track not only SFO's actual international passengers, but also total U.S.-international gateway passengers. These data would allow RAPC to directly compare actual U.S.-international traffic growth by world region to the underlying U.S.-international passenger growth rates assumed in the forecasts to determine if U.S.-international passenger demand is growing faster or slower than forecast. RAPC could also use the data to calculate SFO's actual gateway share by world region for comparison to the SFO gateway shares assumed in the forecast. From these data RAPC could assess whether SFO was gaining or losing international market share relative to the forecast assumptions.

Data Sources

SFO-international and U.S.-international air passenger traffic can be obtained from the U.S. DOT's T-100 International Market database which is available online from the Bureau of Transportation Statistics. The data can be downloaded by destination country and the country level data can then be aggregated into world regions. Data for OAK and SJC may also be downloaded to assess international traffic trends for these Bay Area airports compared to the forecasts.

**T-100 International Market
Database:**

http://www.transtats.bts.gov/Fields.asp?Table_ID=260

3.2.6 Airline Service and Fare Decisions

Although airline services did not directly factor into the forecasts of regional demand, assumptions about the distribution of traffic (and services) between the airports were made to estimate passenger demand by airport in the Base Case and for the scenarios that involved Traffic Redistribution. Section 3.1.1 describes how actual airport passenger levels can be used to track airport shares against the Base Case and Redistribution Scenario forecasts. Another way would be to assess how actual airline service decisions may be affecting the airport level passenger forecasts by tracking changes in airline services at each of the airports. For example, tracking service levels by airline using published airline schedule data can highlight major carrier service decisions that may affect traffic at an individual airport and/or the distribution of traffic between the airports. Exhibits 8 shows a summary of current domestic and international airline services by U.S. and foreign airlines and shows changes over the prior year for each Bay Area airport. The schedule data shows that there is little change in the distribution of domestic services among the airports between February 2011 and February 2010. However, because of growth in international services at SFO, overall services are slightly more concentrated at SFO in February 2011.

Exhibit 8: Weekly Scheduled Airline Seats at Bay Area Airports, February 2010 to February 2011

Airport	Weekly Seats			
	Feb 2010	Feb 2011	Share Feb-10	Share Feb-11
<u>Domestic</u>				
SFO	337,878	338,099	59.8%	60.6%
OAK	123,796	116,336	21.9%	20.8%
SJC	103,312	103,609	18.3%	18.6%
Total	564,986	558,044	100.0%	100.0%
<u>International</u>				
SFO	91,698	96,404	93.7%	97.0%
OAK	5,032	2,016	5.1%	2.0%
SJC	1,100	1,008	1.1%	1.0%
Total	97,830	99,428	100.0%	100.0%
<u>Domestic + International</u>				
SFO	429,576	434,503	64.8%	66.1%
OAK	128,828	118,352	19.4%	18.0%
SJC	104,412	104,617	15.8%	15.9%
Total	662,816	657,472	100.0%	100.0%

Source: OAG

Using the same database, similar comparisons can be made to assess changes in the number of weekly nonstop departures at each of the airport as well as changes in the number of nonstop destinations served.

In addition to tracking airline services using published airline schedules, airport planning managers may also inform RAPC of any significant changes in airline services, such as a major airline withdrawing services from their airport, if it could have a material effect on the forecasts.

Data Sources

Published airline schedule data can be purchased from the Official Airline Guide or private vendors.

Average Airfares in Top Ten O&D Markets by Airport

Since airfare differentials among the three airports can also influence passenger airport choice, RAPC may want to monitor how average fares in the region's top ten destination markets compare by airport. (See Exhibit 7 for the region's top ten O&D markets.)

Data Sources

The average passenger fares for the top ten O&D markets can be obtained from the U.S. DOT, Airline Origin-Destination Survey (DB1B). The data would have to be downloaded from the DB1BTicket

database for all airports in the state of California for each quarter. The downloaded would then need to be processed and summarized with a database application such as MS Access.

**Airline Origin-Destination
Survey DB1B Ticket Data:**

http://www.transtats.bts.gov/Tables.asp?DB_ID=125&DB_Name=Airline%20Origin%20and%20Destination%20Survey%20%28DB1B%29&DB_Short_Name=Origin%20and%20Destination%20Survey

3.3 AVAILABILITY OF TRACKING DATA

Most of the data required to perform the tracking is available by mid year, as shown in Exhibit 9, so the tracking process and forecast adjustment could be conducted after June of the following year (e.g., after June 2016 for tracking 2015 traffic). One exception is personal income for the 9-county Bay Area region which is released with a one and half year lag. For example, 2009 personal income at the county level will not be released until April 2011.

Since actual traffic in the Bay Area declined by 9 percent between 2007 and 2009 and the U.S. economy is in the midst of a slow recovery, it is recommended that the forecast tracking system not begin until Bay Area traffic levels have recovered. The forecasts assumed that Bay Area passenger traffic would recover to the 2007 level in 2011. Actual year-to-year growth rates during a recovery period may be higher than the average long-term forecast growth rates.

Exhibit 9: Data Release Dates

Metric	Source	Approximate Release of Year End Data
Traffic Measures		
Airport Passengers	Airport Statistics	Late January/February
Airport Operations	Airport Statistics	Late January/February
Airport Cargo	Airport Statistics	Late January/February
Traffic Drivers		
Personal Income	BEA, Local Area Personal Income	April (with 2 year lag)
U.S. Gross Domestic Product	BEA	January-March *
Avg Airline Yield	U.S. DOT, DB1B Market	Late April
Cushing, OK WTI Crude Oil Price	U.S. EIA	January
Kerosene-Type Jet Fuel Prices	U.S. EIA	January
U.S.-International Passenger Traffic	U.S. DOT, T-100 International Market	June
Airline Services	OAG	Available Monthly
Other		
CPI-U	BLS	February

* First estimate released in January; second estimate in February and third estimate in March.

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Actual vs. Forecast: Total System Passengers (OAK, SFO, and SJC)

Year	Actual	Forecast		
		Base	Low	High
2007	60,592,224			
2008	58,258,902			
2009	55,051,281			
2010	57,179,631			
2011	-	60,592,224	60,592,224	60,592,224
2012	-	62,060,722	61,423,312	63,057,712
2013	-	63,568,185	62,269,905	65,625,626
2014	-	65,115,703	63,132,305	68,300,292
2015	-	66,704,398	64,010,823	71,086,226
2016	-	68,335,424	64,905,776	73,988,133
2017	-	70,009,969	65,817,485	77,010,923
2018	-	71,729,255	66,746,280	80,159,714
2019	-	73,494,539	67,692,497	83,439,846
2020	-	75,307,115	68,656,477	86,856,888
2021	-	76,806,138	69,811,737	89,161,950
2022	-	78,335,773	70,986,917	91,528,882
2023	-	79,896,660	72,182,367	93,959,363
2024	-	81,489,451	73,398,445	96,455,116
2025	-	83,114,812	74,635,514	99,017,913
2026	-	84,773,425	75,893,943	101,649,574
2027	-	86,465,984	77,174,110	104,351,968
2028	-	88,193,199	78,476,397	107,127,016
2029	-	89,955,796	79,801,195	109,976,691
2030	-	91,754,514	81,148,901	112,903,022
2031	-	93,590,110	82,519,919	115,908,091
2032	-	95,463,357	83,914,662	118,994,039
2033	-	97,375,042	85,333,547	122,163,065
2034	-	99,325,972	86,777,001	125,417,429
2035	-	101,316,970	88,245,459	128,759,451
<u>AAG</u>				
2007-2010	-1.9%			
2011-2020		2.4%	1.4%	4.1%
2020-2035		2.0%	1.7%	2.7%

Actual vs. Forecast: Total Passengers (OAK)

Year	Actual	Forecast		
		Base	Low	High
2007	14,616,594			
2008	11,474,456			
2009	9,505,281			
2010	9,542,333			
2011		14,616,594	14,616,594	14,616,594
2012		14,797,947	14,630,268	15,067,971
2013		14,981,549	14,643,954	15,533,286
2014		15,167,430	14,657,653	16,012,971
2015		15,355,617	14,671,366	16,507,470
2016		15,546,139	14,685,090	17,017,238
2017		15,739,025	14,698,828	17,542,750
2018		15,934,304	14,712,579	18,084,489
2019		16,132,006	14,726,342	18,642,958
2020		16,332,161	14,740,119	19,218,673
2021		16,589,865	14,937,460	19,659,756
2022		16,851,634	15,137,443	20,110,961
2023		17,117,535	15,340,103	20,572,522
2024		17,387,630	15,545,477	21,044,677
2025		17,661,988	15,753,600	21,527,667
2026		17,940,675	15,964,509	22,021,743
2027		18,223,759	16,178,242	22,527,158
2028		18,511,310	16,394,837	23,044,172
2029		18,803,398	16,614,331	23,573,053
2030		19,100,095	16,836,764	24,114,071
2031		19,401,473	17,062,175	24,667,507
2032		19,707,607	17,290,604	25,233,644
2033		20,018,571	17,522,091	25,812,774
2034		20,334,442	17,756,677	26,405,196
2035		20,655,297	17,994,404	27,011,214
<u>AAG</u>				
2007-2010	-13.3%			
2011-2020		1.2%	0.1%	3.1%
2020-2035		1.6%	1.3%	2.3%

Actual vs. Forecast: Total Passengers (SFO)

Year	Actual	Forecast		
		Base	Low	High
2007	35,317,241			
2008	37,066,729			
2009	37,224,250			
2010	39,391,234			
2011		35,317,241	35,317,241	35,317,241
2012		36,380,566	36,033,730	36,909,793
2013		37,475,905	36,764,755	38,574,158
2014		38,604,222	37,510,611	40,313,574
2015		39,766,511	38,271,597	42,131,424
2016		40,963,794	39,048,023	44,031,247
2017		42,197,124	39,840,199	46,016,738
2018		43,467,587	40,648,447	48,091,760
2019		44,776,300	41,473,092	50,260,351
2020		46,124,417	42,314,466	52,526,729
2021		47,160,120	43,114,771	54,040,996
2022		48,219,079	43,930,213	55,598,917
2023		49,301,817	44,761,077	57,201,750
2024		50,408,867	45,607,656	58,850,790
2025		51,540,776	46,470,246	60,547,370
2026		52,698,101	47,349,151	62,292,860
2027		53,881,413	48,244,679	64,088,670
2028		55,091,296	49,157,144	65,936,250
2029		56,328,347	50,086,867	67,837,093
2030		57,593,174	51,034,173	69,792,734
2031		58,886,403	51,999,397	71,804,754
2032		60,208,671	52,982,876	73,874,777
2033		61,560,630	53,984,956	76,004,476
2034		62,942,946	55,005,988	78,195,571
2035		64,356,302	56,046,332	80,449,832
<u>AAG</u>				
2007-2010	3.7%			
2011-2020		3.0%	2.0%	4.5%
2020-2035		2.2%	1.9%	2.9%

Actual vs. Forecast: Total Passengers (SJC)

Year	Actual	Forecast		
		Base	Low	High
2007	10,658,389			
2008	9,717,717			
2009	8,321,750			
2010	8,246,064			
2011		10,658,389	10,658,389	10,658,389
2012		10,882,210	10,759,314	11,079,949
2013		11,110,731	10,861,195	11,518,182
2014		11,344,050	10,964,041	11,973,748
2015		11,582,269	11,067,860	12,447,332
2016		11,825,491	11,172,663	12,939,648
2017		12,073,820	11,278,458	13,451,435
2018		12,327,364	11,385,255	13,983,465
2019		12,586,233	11,493,063	14,536,538
2020		12,850,537	11,601,892	15,111,485
2021		13,056,153	11,759,506	15,461,198
2022		13,265,059	11,919,261	15,819,004
2023		13,477,308	12,081,187	16,185,091
2024		13,692,953	12,245,313	16,559,649
2025		13,912,048	12,411,668	16,942,876
2026		14,134,649	12,580,283	17,334,971
2027		14,360,812	12,751,189	17,736,140
2028		14,590,594	12,924,416	18,146,594
2029		14,824,052	13,099,997	18,566,545
2030		15,061,245	13,277,963	18,996,216
2031		15,302,234	13,458,347	19,435,830
2032		15,547,079	13,641,182	19,885,618
2033		15,795,841	13,826,500	20,345,815
2034		16,048,584	14,014,336	20,816,661
2035		16,305,371	14,204,724	21,298,405
<u>AAG</u>				
2007-2010	-8.2%			
2011-2020		2.1%	0.9%	4.0%
2020-2035		1.6%	1.4%	2.3%

Actual vs. Forecast: International Passengers (SFO)

Year	Actual	Forecast		
		Base	Low	High
2007	8,962,965			
2008	8,964,202			
2009	8,321,146			
2010	8,848,588			
2011		8,962,965	8,962,965	8,962,965
2012		9,334,005	9,278,581	9,395,874
2013		9,720,405	9,605,311	9,849,693
2014		10,122,800	9,943,546	10,325,431
2015		10,541,854	10,293,692	10,824,148
2016		10,978,255	10,656,168	11,346,952
2017		11,432,722	11,031,407	11,895,007
2018		11,906,003	11,419,860	12,469,534
2019		12,398,876	11,821,992	13,071,810
2020		12,912,152	12,238,284	13,703,176
2021		13,360,376	12,591,399	14,263,537
2022		13,824,160	12,954,702	14,846,813
2023		14,304,044	13,328,489	15,453,940
2024		14,800,585	13,713,060	16,085,895
2025		15,314,364	14,108,727	16,743,693
2026		15,845,977	14,515,811	17,428,389
2027		16,396,044	14,934,640	18,141,085
2028		16,965,207	15,365,554	18,882,924
2029		17,554,126	15,808,902	19,655,100
2030		18,163,489	16,265,041	20,458,852
2031		18,794,005	16,734,341	21,295,472
2032		19,446,409	17,217,183	22,166,303
2033		20,121,459	17,713,956	23,072,745
2034		20,819,943	18,225,062	24,016,254
2035		21,542,674	18,750,916	24,998,346
AAG				
2007-2010				
2011-2020		4.1%	3.5%	4.8%
2020-2035		3.5%	2.9%	4.1%

Total Aircraft Operations by Airport, Actual and Forecast

Year	OAK		SFO		SJC	
	Actual	Forecast Base Case	Actual	Forecast Base Case	Actual	Forecast Base Case
2007	337,295		373,015		199,742	
2008	269,631		387,710		172,576	
2009	233,183		379,751		145,838	
2010	219,652		387,248		123,490	
2011		337,295		373,015		199,742
2012		333,066		379,069		200,053
2013		328,891		385,221		200,364
2014		324,767		391,472		200,676
2015		320,696		397,826		200,988
2016		316,675		404,282		201,300
2017		312,705		410,843		201,614
2018		308,785		417,510		201,927
2019		304,914		424,286		202,241
2020		301,091		431,172		202,556
2021		304,412		436,957		205,015
2022		307,770		442,820		207,503
2023		311,165		448,762		210,022
2024		314,597		454,783		212,571
2025		318,067		460,885		215,151
2026		321,576		467,069		217,762
2027		325,123		473,336		220,406
2028		328,709		479,687		223,081
2029		332,335		486,123		225,788
2030		336,001		492,646		228,529
2031		339,707		499,256		231,303
2032		343,454		505,955		234,110
2033		347,242		512,743		236,952
2034		351,073		519,623		239,828
2035		354,945		526,595		242,739
<u>AAG</u>						
2007-2010	-13.3%	-0.6%	1.3%	0.8%	-14.8%	0.1%
2011-2020		-1.3%		1.6%		0.2%
2020-2035		1.1%		1.3%		1.2%

OAK: Forecast Base Case Operations by Type

Year	Psgr Airline	All-Cargo Airline	Total Airline	GA Itinerant	GA - Local	Total GA	Military (Local + Itinerant)	Total All Operations
2007	155,855	32,174	188,029	67,538	81,332	148,870	396	337,295
2008	156,251	32,335	188,586	66,862	77,848	144,709	396	333,691
2009	156,648	32,497	189,144	66,192	74,512	140,705	396	330,245
2010	157,045	32,659	189,704	65,529	71,320	136,850	396	326,950
2011	157,444	32,822	190,266	64,873	68,265	133,138	396	323,800
2012	157,844	32,986	190,830	64,224	65,340	129,564	396	320,790
2013	158,245	33,151	191,396	63,581	62,541	126,122	396	317,914
2014	158,647	33,317	191,964	62,944	59,862	122,806	396	315,165
2015	159,049	33,484	192,533	62,314	57,297	119,611	396	312,540
2016	159,453	33,651	193,104	61,690	54,842	116,532	396	310,032
2017	159,858	33,819	193,677	61,072	52,493	113,565	396	307,638
2018	160,264	33,988	194,252	60,461	50,244	110,705	396	305,353
2019	160,671	34,158	194,829	59,855	48,091	107,947	396	303,172
2020	161,079	34,329	195,408	59,256	46,031	105,287	396	301,091
2021	163,012	34,707	197,719	60,024	46,259	106,283	396	304,398
2022	164,968	35,088	200,056	60,802	46,488	107,291	396	307,743
2023	166,948	35,474	202,422	61,590	46,719	108,309	396	311,127
2024	168,951	35,865	204,816	62,388	46,951	109,339	396	314,551
2025	170,978	36,259	207,238	63,197	47,183	110,380	396	318,014
2026	173,030	36,658	209,688	64,016	47,417	111,433	396	321,518
2027	175,107	37,061	212,168	64,846	47,652	112,498	396	325,062
2028	177,208	37,469	214,677	65,686	47,888	113,575	396	328,648
2029	179,334	37,881	217,215	66,538	48,126	114,664	396	332,275
2030	181,486	38,298	219,784	67,400	48,364	115,765	396	335,945
2031	183,664	38,719	222,383	68,274	48,604	116,878	396	339,657
2032	185,868	39,145	225,013	69,159	48,845	118,004	396	343,413
2033	188,099	39,576	227,674	70,055	49,087	119,142	396	347,212
2034	190,356	40,011	230,367	70,963	49,330	120,294	396	351,056
2035	192,640	40,451	233,091	71,883	49,575	121,458	396	354,945
AAG								
2007-2020	0.3%	0.5%	0.3%	-1.0%	-4.3%	-2.6%	0.0%	-0.9%
2020-2035	1.2%	1.1%	1.2%	1.3%	0.5%	1.0%	0.0%	1.1%

SFO: Forecast Base Case Operations by Type

Year	Psgr Airline	All-Cargo Airline	Total Airline	GA Itinerant	GA - Local	Total GA	Military (Local + Itinerant)	Total All Operations
2007	326,230	9,759	335,989	34,195	134	34,329	2,697	373,015
2008	330,385	9,915	340,301	34,013	-	34,013	2,697	377,010
2009	334,594	10,074	344,668	33,832	-	33,832	2,697	381,196
2010	338,856	10,235	349,091	33,651	-	33,651	2,697	385,439
2011	343,172	10,399	353,571	33,472	-	33,472	2,697	389,740
2012	347,543	10,565	358,108	33,294	-	33,294	2,697	394,099
2013	351,970	10,734	362,704	33,116	-	33,116	2,697	398,518
2014	356,453	10,906	367,359	32,940	-	32,940	2,697	402,996
2015	360,994	11,081	372,074	32,765	-	32,765	2,697	407,536
2016	365,592	11,258	376,850	32,590	-	32,590	2,697	412,137
2017	370,249	11,438	381,687	32,416	-	32,416	2,697	416,800
2018	374,965	11,621	386,586	32,244	-	32,244	2,697	421,527
2019	379,741	11,807	391,548	32,072	-	32,072	2,697	426,317
2020	384,578	11,996	396,574	31,901	-	31,901	2,697	431,172
2021	389,262	12,368	401,630	32,581	-	32,581	2,697	436,908
2022	394,004	12,751	406,755	33,275	-	33,275	2,697	442,727
2023	398,803	13,147	411,950	33,985	-	33,985	2,697	448,631
2024	403,661	13,554	417,215	34,709	-	34,709	2,697	454,621
2025	408,577	13,974	422,552	35,449	-	35,449	2,697	460,697
2026	413,554	14,407	427,962	36,204	-	36,204	2,697	466,863
2027	418,592	14,854	433,446	36,976	-	36,976	2,697	473,119
2028	423,690	15,314	439,005	37,764	-	37,764	2,697	479,466
2029	428,851	15,789	444,640	38,569	-	38,569	2,697	485,906
2030	434,075	16,279	450,353	39,391	-	39,391	2,697	492,441
2031	439,362	16,783	456,145	40,231	-	40,231	2,697	499,073
2032	444,714	17,303	462,017	41,088	-	41,088	2,697	505,802
2033	450,131	17,840	467,970	41,964	-	41,964	2,697	512,631
2034	455,613	18,393	474,006	42,858	-	42,858	2,697	519,562
2035	461,163	18,963	480,126	43,772	-	43,772	2,697	526,595
AAG								
2007-2020	1.3%	1.6%	1.3%	-0.5%	-	-0.6%	0.0%	1.1%
2020-2035	1.2%	3.1%	1.3%	2.1%	-	2.1%	0.0%	1.3%

SJC: Forecast Base Case Operations by Type

Year	Psgr Airline	All-Cargo Airline	Total Airline	GA Itinerant	GA - Local	Total GA	Military (Local + Itinerant)	Total All Operations
2007	155,855	32,174	188,029	67,538	81,332	148,870	396	337,295
2008	156,251	32,335	188,586	66,862	77,848	144,709	396	333,691
2009	156,648	32,497	189,144	66,192	74,512	140,705	396	330,245
2010	157,045	32,659	189,704	65,529	71,320	136,850	396	326,950
2011	157,444	32,822	190,266	64,873	68,265	133,138	396	323,800
2012	157,844	32,986	190,830	64,224	65,340	129,564	396	320,790
2013	158,245	33,151	191,396	63,581	62,541	126,122	396	317,914
2014	158,647	33,317	191,964	62,944	59,862	122,806	396	315,165
2015	159,049	33,484	192,533	62,314	57,297	119,611	396	312,540
2016	159,453	33,651	193,104	61,690	54,842	116,532	396	310,032
2017	159,858	33,819	193,677	61,072	52,493	113,565	396	307,638
2018	160,264	33,988	194,252	60,461	50,244	110,705	396	305,353
2019	160,671	34,158	194,829	59,855	48,091	107,947	396	303,172
2020	161,079	34,329	195,408	59,256	46,031	105,287	396	301,091
2021	163,012	34,707	197,719	60,024	46,259	106,283	396	304,398
2022	164,968	35,088	200,056	60,802	46,488	107,291	396	307,743
2023	166,948	35,474	202,422	61,590	46,719	108,309	396	311,127
2024	168,951	35,865	204,816	62,388	46,951	109,339	396	314,551
2025	170,978	36,259	207,238	63,197	47,183	110,380	396	318,014
2026	173,030	36,658	209,688	64,016	47,417	111,433	396	321,518
2027	175,107	37,061	212,168	64,846	47,652	112,498	396	325,062
2028	177,208	37,469	214,677	65,686	47,888	113,575	396	328,648
2029	179,334	37,881	217,215	66,538	48,126	114,664	396	332,275
2030	181,486	38,298	219,784	67,400	48,364	115,765	396	335,945
2031	183,664	38,719	222,383	68,274	48,604	116,878	396	339,657
2032	185,868	39,145	225,013	69,159	48,845	118,004	396	343,413
2033	188,099	39,576	227,674	70,055	49,087	119,142	396	347,212
2034	190,356	40,011	230,367	70,963	49,330	120,294	396	351,056
2035	192,640	40,451	233,091	71,883	49,575	121,458	396	354,945
AAG								
2007-2020	0.3%	0.5%	0.3%	-1.0%	-4.3%	-2.6%	0.0%	-0.9%
2020-2035	1.2%	1.1%	1.2%	1.3%	0.5%	1.0%	0.0%	1.1%

Actual vs. Forecast: Total System Cargo Tons (OAK, SFO, and SJC)

Year	Actual	Forecast		
		Base	Low	High
2007	1,425,818			
2008				
2009				
2010				
2011		1,425,818	1,425,818	1,425,818
2012		1,463,626	1,450,858	1,476,560
2013		1,502,437	1,476,337	1,529,108
2014		1,542,277	1,502,264	1,583,526
2015		1,583,173	1,528,646	1,639,881
2016		1,625,153	1,555,491	1,698,241
2017		1,668,247	1,582,808	1,758,678
2018		1,712,483	1,610,605	1,821,266
2019		1,757,893	1,638,890	1,886,081
2020		1,804,506	1,667,671	1,953,203
2021		1,855,438	1,698,191	2,028,779
2022		1,907,808	1,729,270	2,107,280
2023		1,961,655	1,760,918	2,188,819
2024		2,017,023	1,793,145	2,273,512
2025		2,073,953	1,825,962	2,361,483
2026		2,132,490	1,859,379	2,452,857
2027		2,192,679	1,893,408	2,547,767
2028		2,254,567	1,928,060	2,646,350
2029		2,318,202	1,963,346	2,748,747
2030		2,383,633	1,999,278	2,855,106
2031		2,450,910	2,035,867	2,965,581
2032		2,520,087	2,073,126	3,080,330
2033		2,591,216	2,111,066	3,199,519
2034		2,664,353	2,149,702	3,323,321
2035		2,739,554	2,189,044	3,451,912
<u>AAG</u>				
2007-2010	-100.0%			
2011-2020		2.7%	1.8%	3.6%
2020-2035		2.8%	1.8%	3.9%

Note: Includes freight and mail.

Actual vs. Forecast: Total System Cargo Tons (OAK)

Year	Actual	Forecast		
		Base	Low	High
2007	713,866			
2008	685,789			
2009	541,497			
2010	563,337			
2011		713,866	713,866	713,866
2012		728,943	723,916	733,970
2013		744,338	734,108	754,641
2014		760,059	744,443	775,894
2015		776,111	754,924	797,746
2016		792,503	765,552	820,213
2017		809,241	776,330	843,312
2018		826,332	787,260	867,062
2019		843,784	798,344	891,482
2020		861,605	809,583	916,588
2021		879,818	820,988	942,431
2022		898,417	832,553	969,003
2023		917,408	844,282	996,324
2024		936,801	856,175	1,024,415
2025		956,603	868,236	1,053,298
2026		976,825	880,467	1,082,995
2027		997,473	892,871	1,113,530
2028		1,018,559	905,449	1,144,926
2029		1,040,090	918,204	1,177,207
2030		1,062,076	931,139	1,210,398
2031		1,084,527	944,256	1,244,525
2032		1,107,452	957,558	1,279,614
2033		1,130,862	971,047	1,315,692
2034		1,154,767	984,727	1,352,788
2035		1,179,177	998,599	1,390,929
<u>AAG</u>				
2007-2010	-7.6%			
2011-2020		2.1%	1.4%	2.8%
2020-2035		2.1%	1.4%	2.8%

Note: Includes freight and mail.

Actual vs. Forecast: Total System Cargo Tons (SFO)

Year	Actual	Forecast		
		Base	Low	High
2007	620,527			
2008	544,132			
2009	449,855			
2010	470,383			
2011		620,527	620,527	620,527
2012		641,158	634,165	648,261
2013		662,476	648,104	677,234
2014		684,502	662,348	707,503
2015		707,261	676,906	739,124
2016		730,777	691,784	772,159
2017		755,074	706,989	806,670
2018		780,179	722,528	842,724
2019		806,119	738,408	880,389
2020		832,921	754,638	919,737
2021		862,696	772,087	964,798
2022		893,534	789,939	1,012,066
2023		925,475	808,204	1,061,650
2024		958,558	826,892	1,113,664
2025		992,824	846,012	1,168,226
2026		1,028,314	865,574	1,225,461
2027		1,065,073	885,588	1,285,500
2028		1,103,146	906,064	1,348,480
2029		1,142,580	927,015	1,414,546
2030		1,183,423	948,450	1,483,849
2031		1,225,727	970,380	1,556,547
2032		1,269,543	992,817	1,632,807
2033		1,314,925	1,015,774	1,712,803
2034		1,361,929	1,039,261	1,796,719
2035		1,410,614	1,063,291	1,884,745
<u>AAG</u>				
2007-2010	-8.8%			
2011-2020		3.3%	2.2%	4.5%
2020-2035		3.6%	2.3%	4.9%

Note: Includes freight and mail.

Actual vs. Forecast: Total System Cargo Tons (SJC)

Year	Actual	Forecast		
		Base	Low	High
2007	91,426			
2008	81,222			
2009	59,471			
2010	49,363			
2011		91,426	91,426	91,426
2012		93,322	92,690	93,955
2013		95,258	93,971	96,554
2014		97,234	95,270	99,225
2015		99,251	96,587	101,970
2016		101,309	97,922	104,791
2017		103,410	99,276	107,690
2018		105,555	100,648	110,669
2019		107,745	102,040	113,731
2020		109,980	103,450	116,877
2021		112,267	104,883	120,121
2022		114,602	106,335	123,456
2023		116,985	107,808	126,883
2024		119,418	109,301	130,405
2025		121,901	110,815	134,025
2026		124,437	112,349	137,745
2027		127,025	113,905	141,569
2028		129,666	115,483	145,499
2029		132,363	117,082	149,538
2030		135,116	118,703	153,689
2031		137,926	120,347	157,955
2032		140,794	122,014	162,340
2033		143,722	123,704	166,846
2034		146,711	125,417	171,478
2035		149,762	127,154	176,238
<u>AAG</u>				
2007-2010	-18.6%			
2011-2020		2.1%	1.4%	2.8%
2020-2035		2.1%	1.4%	2.8%

Note: Includes freight and mail.

Forecast Real Weighted Average Yield by Year

Year	Actual	Base	Forecast Low	High
2007	\$0.1358			
2008				
2009				
2010				
2011		\$0.1394	\$0.1466	\$0.1324
2012		\$0.1403	\$0.1495	\$0.1315
2013		\$0.1412	\$0.1524	\$0.1307
2014		\$0.1422	\$0.1553	\$0.1299
2015		\$0.1431	\$0.1584	\$0.1291
2016		\$0.1441	\$0.1614	\$0.1283
2017		\$0.1450	\$0.1646	\$0.1274
2018		\$0.1460	\$0.1678	\$0.1266
2019		\$0.1469	\$0.1710	\$0.1258
2020		\$0.1479	\$0.1743	\$0.1250
2021		\$0.1482	\$0.1747	\$0.1250
2022		\$0.1486	\$0.1751	\$0.1249
2023		\$0.1489	\$0.1755	\$0.1249
2024		\$0.1492	\$0.1760	\$0.1248
2025		\$0.1496	\$0.1764	\$0.1247
2026		\$0.1499	\$0.1768	\$0.1247
2027		\$0.1503	\$0.1772	\$0.1246
2028		\$0.1506	\$0.1776	\$0.1246
2029		\$0.1509	\$0.1780	\$0.1245
2030		\$0.1513	\$0.1784	\$0.1244
2031		\$0.1516	\$0.1788	\$0.1244
2032		\$0.1520	\$0.1792	\$0.1243
2033		\$0.1523	\$0.1796	\$0.1243
2034		\$0.1526	\$0.1800	\$0.1242
2035		\$0.1530	\$0.1804	\$0.1242
<u>AAG</u>				
2011-2020		0.7%	1.9%	-0.6%
2020-2035		0.2%	0.2%	0.0%

Forecast Oil Prices by Year
Cushing, OK WTI Spot Price FOB (Dollars per Barrel)

Year	Actual	Forecast		
		Base	Low	High
2007	\$72.34			
2008	\$95.98			
2009	\$59.87			
2010	\$75.57			
2011		\$83.43	\$95.76	\$64.57
2012		\$86.46	\$102.72	\$62.76
2013		\$89.60	\$110.18	\$61.00
2014		\$92.85	\$118.18	\$59.29
2015		\$96.22	\$126.77	\$57.63
2016		\$99.71	\$135.97	\$56.02
2017		\$103.33	\$145.85	\$54.45
2018		\$107.08	\$156.45	\$52.92
2019		\$110.97	\$167.81	\$51.44
2020		\$115.00	\$180.00	\$50.00
2021		\$116.42	\$181.91	\$50.00
2022		\$117.85	\$183.83	\$50.00
2023		\$119.31	\$185.78	\$50.00
2024		\$120.78	\$187.75	\$50.00
2025		\$122.27	\$189.74	\$50.00
2026		\$123.78	\$191.75	\$50.00
2027		\$125.31	\$193.78	\$50.00
2028		\$126.85	\$195.83	\$50.00
2029		\$128.42	\$197.90	\$50.00
2030		\$130.00	\$200.00	\$50.00
2031		\$131.07	\$201.41	\$50.00
2032		\$132.14	\$202.83	\$50.00
2033		\$133.23	\$204.26	\$50.00
2034		\$134.32	\$205.70	\$50.00
2035		\$135.42	\$207.15	\$50.00
<u>AAG</u>				
2007-2010	1.5%			
2007-2020		3.6%	7.3%	-2.8%
2020-2035		1.1%	0.9%	0.0%



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Appendix B: ON-LINE DATA RESOURCES



Park Close. Fly on time.

4-Mar-2011 1:56 PM

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OAKLAND INTERNATIONAL AIRPORT
MONTHLY ACTIVITY REPORT
CALENDAR YEAR

	DEC 10	DEC 09	INC/DEC	CY 10	CY 09	INC/DEC
PASSENGER TOTALS						
ENPLANING	400,606	414,716	-3.40%	4,769,915	4,750,185	0.42%
DEPLANING	392,794	401,513	-2.17%	4,772,418	4,755,096	0.36%
TOTAL	793,400	816,229	-2.80%	9,542,333	9,505,281	0.39%
AIRCRAFT MOVEMENTS						
TOTAL	16,608	18,408	-9.78%	219,652	233,183	-5.80%
AVIATION FUEL (GALS)						
GENERAL AVIATION	644,053	614,971	4.73%	7,544,700	7,087,316	6.45%
CONTRACT SALES	8,879,685	8,527,902	4.13%	90,034,379	96,027,124	-6.24%
TOTAL	9,523,738	9,142,873	4.17%	97,579,079	103,114,440	-5.37%
AIR MAIL (M lbs)						
MAIL IN	809	897	-9.81%	12,468	10,193	22.32%
MAIL OUT	542	912	-40.57%	7,934	8,872	-10.57%
TOTAL	1,351	1,809	-25.32%	20,402	19,065	7.01%
FREIGHT (M lbs)						
FREIGHT IN	54,818	51,800	5.83%	536,985	509,627	5.37%
FREIGHT OUT	60,185	54,588	10.25%	569,287	554,302	2.70%
TOTAL	115,003	106,388	8.10%	1,106,272	1,063,929	3.98%
AIR MAIL & FREIGHT (M lbs)						
IN	55,627	52,697	5.56%	549,453	519,820	5.70%
OUT	60,727	55,500	9.42%	577,221	563,174	2.49%
TOTAL	116,354	108,197	7.54%	1,126,674	1,082,994	4.03%
LANDED WEIGHTS (M lbs)						
PAX CARRIERS	496,189	546,296	-9.17%	6,114,587	6,415,554	-4.69%
CARGO CARRIERS	304,859	267,699	13.88%	2,612,281	2,708,730	-3.56%
TOTAL	801,048	813,995	-1.59%	8,726,868	9,124,284	-4.36%
AIRBART RIDERS						
TO AIRPORT	32,966	32,391	1.78%	354,531	363,605	-2.50%
TO BART	30,755	31,466	-2.26%	397,804	408,790	-2.69%
TOTAL REVENUE (\$)	187,035	181,010	3.33%	2,148,960	2,185,185	-1.66%
PARKING LOT						
DAILY EXITS	19,498	19,838	-1.71%	271,493	273,257	-0.65%
HOURLY EXITS	44,558	51,234	-13.03%	488,004	545,302	-10.51%
ECONOMY EXITS	9,640	9,939	-3.01%	134,818	139,517	-3.37%
VALET EXITS	0	0	NO ACT	0	11,400	NO ACTVY
TOTAL REVENUE (\$)	1,724,074	1,674,962	2.93%	23,676,901	22,684,592	4.37%
CONCESSIONS						
SHOPS	888,121	930,764	-4.58%	10,804,228	11,446,023	-5.61%
RESTAURANT/BAR	1,955,849	1,904,772	2.68%	22,100,688	21,443,659	3.06%
TOTAL REVENUE (\$)	2,843,971	2,835,536	0.30%	32,904,916	32,889,681	0.05%
CAR RENTALS REVENUE (\$)	5,347,809	5,539,378	-3.46%	79,393,104	81,795,016	-2.94%

MOVING 12 MONTH PASSENGER TOTALS

JAN 1, 2010 THRU DEC 31, 2010	9,542,333
JAN 1, 2009 THRU DEC 31, 2009	9,505,281
	0.39%

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Monthly analyses of scheduled airline traffic, including a comparative traffic report of flight operations, enplaned and deplaned passengers, cargo and U.S. mail, are available for download in PDF format. To obtain a free PDF reader, please visit the [Adobe website](#).

[January](#)

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Analysis of Scheduled Airline Traffic
COMPARATIVE TRAFFIC REPORT
Dec-10

San Francisco International Airport



Monthly Comparison

Calendar Year-to-Date

	Dec-10	Dec-09	% Change	2010	2009	% Change
Flight Operations - Total *	31,573	31,185	1.2%	387,248	379,751	2.0%
Air Carrier	23,755	23,517	1.0%	288,475	280,958	2.7%
Air Taxi	6,838	6,595	3.7%	83,493	83,722	-0.3%
Civil	828	925	-10.5%	12,570	12,293	2.3%
Military	152	148	2.7%	2,710	2,778	-2.4%
Revenue Landed Weight (000 lbs.)	2,348,309	2,346,379	0.1%	28,885,514	28,434,838	1.6%
Total Airport Passengers **	3,177,096	3,083,736	3.0%	39,391,234	37,453,634	5.2%
Total Enplaned & Deplaned	3,157,152	3,064,682	3.0%	39,116,764	37,224,250	5.1%
Total Enplaned	1,591,589	1,550,460	2.7%	19,539,692	18,611,271	5.0%
Total Deplaned	1,565,563	1,514,222	3.4%	19,577,072	18,612,979	5.2%
Domestic	2,469,098	2,398,450	2.9%	30,268,176	28,903,104	4.7%
Enplanements	1,244,293	1,205,993	3.2%	15,145,876	14,450,146	4.8%
Deplanements	1,224,805	1,192,457	2.7%	15,122,300	14,452,958	4.6%
International	688,054	666,232	3.3%	8,848,588	8,321,146	6.3%
Enplanements	347,296	344,467	0.8%	4,393,816	4,161,125	5.6%
Deplanements	340,758	321,765	5.9%	4,454,772	4,160,021	7.1%
Total U.S. Mail (metric tons)	4,837	6,166	-21.6%	42,545	51,836	-17.9%
Domestic	2,955	2,929	0.9%	22,437	24,608	-8.8%
International	1,882	3,238	-41.9%	20,108	27,228	-26.1%
Total Cargo *** (metric tons)	33,048	31,417	5.2%	384,179	356,266	7.8%
Domestic	9,486	13,556	-30.0%	126,981	141,246	-10.1%
International	23,562	17,861	31.9%	257,198	215,020	19.6%
Total Cargo and U.S. Mail (metric tons)	37,885	37,583	0.8%	426,724	408,102	4.6%
Cars Exited (Garage and Lot)	288,042	274,876	4.8%	3,233,408	3,158,740	2.4%

*SFO ATCT Traffic Control Count

**Total airport passengers include total enplaned and deplaned passengers and passengers who fly into and out of SFO on the same aircraft.

***Excludes mail

Analysis of Scheduled Airline Traffic
INTERNATIONAL SUMMARY REPORT
Dec-10

San Francisco International Airport



Monthly Comparison

	Dec-10	Dec-09	% Change
International Flight Operations	3,962	3,840	3.2%
Domestic Carriers	1,760	1,598	10.1%
Foreign Flag Carriers	2,202	2,242	-1.8%

Calendar Year-to-Date

	2010	2009	% Change
International Flight Operations	48,730	48,098	1.3%
Domestic Carriers	20,118	19,914	1.0%
Foreign Flag Carriers	28,612	28,184	1.5%

Total Airport International Passengers **	695,748	671,816	3.6%	8,945,026	8,397,816	6.5%
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Total International Enplaned and Deplaned	688,054	666,232	3.3%	8,848,588	8,321,146	6.3%
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Europe	140,715	136,125	3.4%	2,158,847	2,181,151	-1.0%
Enplanements	69,422	68,024	2.1%	1,080,551	1,096,353	-1.4%
Deplanements	71,293	68,101	4.7%	1,078,296	1,084,798	-0.6%

Asia/Middle East	342,335	336,687	1.7%	4,197,762	3,801,310	10.4%
Enplanements	175,027	175,887	-0.5%	2,064,828	1,881,184	9.8%
Deplanements	167,308	160,800	4.0%	2,132,934	1,920,126	11.1%

Australia/Oceania	44,291	41,416	6.9%	449,478	475,357	-5.4%
Enplanements	21,201	21,200	0.0%	220,214	234,419	-6.1%
Deplanements	23,090	20,216	14.2%	229,264	240,938	-4.8%

Latin America	66,425	71,618	-7.3%	743,453	705,980	5.3%
Enplanements	35,901	39,895	-10.0%	369,024	358,340	3.0%
Deplanements	30,524	31,723	-3.8%	374,429	347,640	7.7%

Canada	94,288	80,386	17.3%	1,299,048	1,157,348	12.2%
Enplanements	45,745	39,461	15.9%	659,199	590,829	11.6%
Deplanements	48,543	40,925	18.6%	639,849	566,519	12.9%

Total International Cargo & Mail (metric tons)	25,444	21,099	20.6%	277,306	242,248	14.5%
Europe	4,243	4,074	4.2%	52,707	46,049	14.5%
Asia/Middle East	19,587	16,035	22.1%	209,489	184,514	13.5%
Australia/Oceania	1,130	796	41.9%	11,240	9,858	14.0%
Latin America	421	76	453.8%	2,826	892	216.7%
Canada	63	117	-46.4%	1,045	934	11.9%

** Total airport international passengers include total enplaned and deplaned passengers and passengers who fly into and out of SFO on the same aircraft

Mineta San José International Airport - SJC

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Airport Activity

You will need Adobe Acrobat Reader to view the PDF documents. Download this free software from Adobe's website at www.adobe.com/products/acrobat/readstep2.html.

Activity Reports

The Airport Activity Reports provide statistical information on SJC's passenger data, traffic counts, cargo levels and much more. The reports are published here on a monthly basis; in a portable document format (PDF).

[Calendar Year](#) [Fiscal Year](#) 

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NORMAN Y. MINETA SAN JOSÉ INTERNATIONAL AIRPORT
MONTHLY ACTIVITY REPORT FOR 12/01/2010 to 12/31/2010 (Calendar Year)

2/3/2011

	12/2010	12/2009	↑↓ (%)	YTD/2010	YTD/2009	↑↓ (%)
Passengers						
O&D Dom. - Enplane	336,990	325,532	3.5%	3,953,775	3,973,184	-0.5%
O&D Dom. - Deplane	328,195	316,325	3.8%	3,965,693	3,992,915	-0.7%
O&D Intl. - Enplane	7,161	4,650	54.0%	69,995	56,238	24.5%
O&D Intl. - Deplane	5,484	6,942	-21.0%	65,427	59,651	9.7%
Connect Enplane	9,201	9,349	-1.6%	95,587	119,881	-20.3%
Connect Deplane	9,201	9,349	-1.6%	95,587	119,881	-20.3%
	696,232	672,147	3.6%	8,246,064	8,321,750	-0.9%
Passengers - Total						
Enplaned	353,352	339,531	4.1%	4,119,357	4,149,303	-0.7%
Deplaned	342,880	332,616	3.1%	4,126,707	4,172,447	-1.1%
	696,232	672,147	3.6%	8,246,064	8,321,750	-0.9%
MAIL/FREIGHT/CARGO (lbs.)						
Mail	121,513	245,582	-50.5%	3,862,551	1,712,796	125.5%
Freight	448,299	522,555	-14.2%	5,178,207	5,658,771	-8.5%
Intl. Cargo	0	17,095	-100.0%	0	162,658	-100.0%
Domestic Cargo	9,483,784	11,748,624	-19.3%	89,684,540	111,408,337	-19.5%
	10,053,596	12,533,856	-19.8%	98,725,298	118,942,562	-17.0%
Traffic Operations						
Passenger Carrier	6,076	6,170	-1.5%	73,586	80,232	-8.3%
Taxi/Commuter	1,432	1,530	-6.4%	16,956	22,542	-24.8%
Subtotal Passenger Operations	7,508	7,700	-2.5%	90,542	102,774	-11.9%
Cargo Carrier	210	222	-5.4%	1,984	2,364	-16.1%
Military	19	21	-9.5%	273	358	-23.7%
GA Local	229	148	54.7%	4,356	13,776	-68.4%
GA Itinerant	1,862	1,736	7.3%	26,335	26,566	-0.9%
	9,828	9,827	0.0%	123,490	145,838	-15.3%
Landed Wgts (1000 lbs.)						
PAX Carrier	398,317	396,894	0.4%	4,772,056	5,165,466	-7.6%
Taxi/Commuter	38,953	40,578	-4.0%	451,972	550,068	-17.8%
Cargo Carrier	33,360	35,820	-6.9%	311,225	371,981	-16.3%
	470,630	473,292	-0.6%	5,535,252	6,087,515	-9.1%
AV Fuel (gal.)						
Retail AV Gas	3,957	4,613	-14.2%	66,316	65,204	1.7%
Retail Jet	621,067	544,776	14.0%	7,961,422	7,047,968	13.0%
Contract Jet	4,985,519	4,456,620	11.9%	57,273,020	57,745,398	-0.8%
	5,610,542	5,006,009	12.1%	65,300,758	64,858,570	0.7%
Parking						
Hourly Exits	84,027	72,809	15.4%	842,910	835,268	0.9%
Daily Exits	13,975	14,864	-6.0%	201,577	213,178	-5.4%
	98,002	87,673	11.8%	1,044,487	1,048,446	-0.4%
Taxicab Operations						
Taxi Trips	20,094	20,412	-1.6%	287,009	276,206	3.9%
PFC Revenue (prev. month)						
November ,10	1,291,716	1,168,973	10.5%	15,960,269	15,958,520	0.0%
MOVING 12 MONTH PASSENGER TOTALS (Combined)						
Jan thru Dec				8,246,064	8,321,750	-0.9%

NOTES:

- 1) YTD information adjusted to include late reporting and/or revisions to prior period
- 2) All figures are month-end activity as reported by airlines and other tenants at San Jose Intl.

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Air Traffic Activity System (ATADS)

The Air Traffic Activity Data System (ATADS) contains the official NAS air traffic operations data available for public release. On the 20th of each month, data for the previous month is made available. The first year of data available is FY 1990.

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ABOUT TAF

Terminal Area Forecast

The **Terminal Area Forecast (TAF)** system is the official forecast of aviation activity at FAA facilities. These forecasts are prepared to meet the budget and planning needs of FAA and provide information for use by state and local authorities, the aviation industry, and the public. The TAF includes forecasts for:

- FAA towered airports
- Federally contracted towered airports
- Nonfederal towered airports
- Non-towered airports

Detailed forecasts are prepared for major users of the National Aviation System including:

- Large air carriers
- Air taxi/commuters
- General aviation
- Military

The TAF includes forecasts for active airports in the National Plan of Integrated Airport System (NPIAS).

The historical data and forecasts are located on an FAA Internet server and may be queried without additional software using any web browser. The Internet interface also allows users to create summary reports and user defined forecasts. Please use the "Detailed Model" link to the left. In addition, the public may download TAF databases, in zipped dbf format, through the "Download 2010 Data" link to the upper left. This data is zipped as APO100_TAF_Final_2010.zip and is about 2.0 MB.

Once published the TAF remains constant until its next publication with the only exceptions being significant traffic shifts by major airlines or the revelation of a significant historical data error. Any such change in an airport forecast will be noted on this page.

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Local Area Personal Income

Step 1. Select a table

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[CA1-3](#)—Personal income, population, per capita personal income
[CA04](#)—Personal income and employment summary
[CA05](#)—Personal income and detailed earnings by industry
[CA06](#)—Compensation by industry
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[CA34](#)—Total wages, wage employment, average wage per job
[CA35](#)—Personal current transfers detail
[CA45](#)—Farm income and expenses
[CA91](#)—Gross Commuters' Earnings Flows
[Single Line](#) of data for all counties (more than 3000 rows returned; please limit years selected to speed process)

Step 2. Select one estimate, one area, and one or more years, then press *Display* to view a table, or *Download* to retrieve comma-separated-value (CSV) text.

CA1-3 — personal income summary estimates

1 Personal income
 2 Population
 3 Per capita personal income

U.S., States, and regions	2008
All Metropolitan Areas*	2007
Metropolitan Statistical Areas*	2006
Micropolitan Statistical Areas*	2005
Metropolitan Divisions*	2004
Combined Statistical Areas*	2003
BEA Economic Areas**	2002
State Metro/Nonmetro Portions***	2001
Alabama	2000
Alaska	1999

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Notes:

*See [Metropolitan Statistical Area definitions](#)

**November 2004 redefinition of the [BEA economic areas](#)

***Nonmetropolitan state portion includes micropolitan counties.

County compensation for 2009 was released on December 21, 2010.

Advance metropolitan area personal income for 2009 was released on August 9, 2010.

New estimates for 2008 and revisions for 1969-2007 were released on [April 22, 2010](#). These estimates incorporate the results of the comprehensive

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revision to the national income and product accounts released in July 2009 and of the comprehensive revision to the state income accounts released in October 2009. Additionally, population was revised back to the year 2000. The next local area release is scheduled for April 21, 2011.

These estimates incorporate the [December 2009 update](#) to the OMB [metropolitan area definitions](#).

Help:

- ▶ Use the CTRL and/or Shift keys to select multiple areas and years. (In the Local Area Personal Income application multiple areas are not selectable; select one state and proceed from there, or select the "Single Line" option in Step 1.) Press *Display* to display your selection in HTML tables, and *Download* to download a comma-separated-value text file. If you select *Download* a "Save As" dialog box will appear. It is recommended that you specify an output filename with a CSV extension. Some users will have the option to open the downloaded file directly into a spreadsheet application.
- ▶ The greater the number of areas and years selected, the slower the request will be. A submission that requests too much information has the possibility of timing out. If you are displaying information, you will want to consider how large your table will be.
- ▶ To view county-level information first display a state.
- ▶ After displaying a table, you have the option to show one estimate for all counties and MSAs in that state by clicking on the line code next to the estimate.

Additional statistics

- ▶ Interactive Maps — The local area estimates in the above tables are also available in a mapping application, [Personal Income and Employment Interactive Map](#)
- ▶ Interactive Charts and Graphs — The local area estimates in the above tables are also available in a charting application, [Regional Economic Accounts Interactive Charts and Graphs](#)
- ▶ REIS DVD — The local area estimates in the above tables also appear on the Regional Economic Information System (REIS) DVD, which is available for [ordering](#). A [downloadable](#) package of REIS estimates and software is also available.
- ▶ All Advance Metropolitan Statistical Area (AMSA) tables are [available for download](#) (ZIP • 3,890 KB) .
- ▶ CA1-3 Personal income, per capita personal income, and population, is [available for download](#) (ZIP • 1,902 KB) .
- ▶ CA34 County and MSA total wage and salary disbursements, total wage employment, and average wage per job, is [available for download](#) (ZIP • 1,866 KB) .
- ▶ CA06 Compensation table for all areas is [available for download](#) (ZIP • 19,120 KB) .
- ▶ CA91 Flow of Earnings table for all counties is [available for download](#) (ZIP • 678 KB) .
- ▶ Personal income and per capita personal income, 2006-2008, with year 2008 rankings of per capita personal income.
Choose an area from this list—

Metropolitan Statistical Areas*	▲
BEA Economic Areas**	■
Alabama	
Alaska	
Arizona	
Arkansas	
California	▼

- ▶ [BEARFACTS](#), a narrative about an area's personal income using current estimates, growth rates, and a breakdown of the sources of personal income.
- ▶ [Journey to Work](#)— the number of commuters from a county of residence to a county of work, for 1970, 1980, 1990, and 2000.
- ▶ 250 [highest](#) and [lowest](#) per capita personal incomes of the 3112 counties in the United States, 2008
- ▶ [County and MSA rankings in the United States for per capita personal income and personal income](#)

Last updated: Tuesday, December 21, 2010

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Real GDP

• +2.8% in Q4 2010 (second estimate)
 [Release: 2/25/11]

Personal Income

• +1.0% in January 2011
 [Release: 2/28/11]

Int'l Trade in Goods and Services

• Deficit increased to \$40.6 billion in December 2010(p) from \$38.3 billion in November 2010(r).
 [Release: 2/11/11]

U.S. Int'l Transactions

• Current-account deficit increased \$4.0 billion to \$127.2 billion in Q3 2010(p).
 [Release: 12/16/10]

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Database Name: Airline Origin and Destination Survey (DB1B)

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Description

Note: 1- Over time both the code and the name of a carrier may change and the same code or name may be assumed by a different airline. To ensure that you are analyzing data from the same airline, TranStats provides four airline-specific variables that identify one and only one carrier or its entity: Airline ID (AirlineID), Unique Carrier Code (UniqueCarrier), Unique Carrier Name (UniqueCarrierName), and Unique Entity (UniqCarrierEntity). A unique airline (carrier) is defined as one holding and reporting under the same DOT certificate regardless of its Code, Name, or holding company/corporation.

2- Local traffic carried by ExpressJet Airlines is under represented from the 2nd quarter 2007 to the present.

[DB1BCoupon](#)

This table provides coupon-specific information for each domestic itinerary of the Origin and Destination Survey, such as the operating carrier, origin and destination airports, number of passengers, fare class, coupon type, trip break indicator, and distance.

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This table contains directional market characteristics of each domestic itinerary of the Origin and Destination Survey, such as the reporting carrier, origin and destination airport, prorated market fare, number of market coupons, market miles flown, and carrier change indicators.

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Annual Passenger Yield: U.S. Airlines

The data below reflects the scheduled service of U.S. airlines, including domestic and international passenger yield, as well as each year's U.S. consumer price index (CPI). ["Yield" denotes the price(in cents) a passenger pays to fly one mile (an "RPM"), not including taxes, which are remitted directly to the taxing authority and never recorded in carrier financial statements.] Inclusion of the annual CPI facilitates comparisons of historical growth in airline prices versus the average basket of U.S. goods. The rightmost column reformulates annual system yields in constant 1978 cents. The table thus portrays airfares in both nominal (not adjusted for U.S. inflation) and real (adjusted for U.S. inflation) terms, using 1978, the year in which Congress deregulated domestic air service.

Year	Nominal Yield: DOM	Nominal Yield: INT	Nominal Yield: SYS	U.S. CPI	Real Yield: DOM	Real Yield: INT	Real Yield: SYS
1926	12.03			17.7	44.31	NA	NA
1927	10.60			17.4	39.72	NA	NA
1928	11.00			17.1	41.94	NA	NA
1929	12.00			17.1	45.75	NA	NA
1930	8.30			16.7	32.40	NA	NA
1931	6.70			15.2	28.74	NA	NA
1932	6.10			13.7	29.03	NA	NA
1933	6.10			13.0	30.59	NA	NA
1934	5.90			13.4	28.71	NA	NA
1935	5.70			13.7	27.13	NA	NA
1936	5.70			13.9	26.74	NA	NA
1937	5.60	8.63	5.94	14.4	25.36	39.07	26.90
1938	5.18	8.34	5.50	14.4	23.45	37.76	24.90
1939	5.10	8.57	5.43	13.9	23.92	40.20	25.47
1940	5.07	8.83	5.39	14.0	23.61	41.12	25.10
1941	5.04	8.61	5.42	14.7	22.35	38.19	24.04
1942	5.34	8.86	5.85	16.3	21.36	35.44	23.40
1943	5.35	7.94	5.69	17.3	20.16	29.92	21.44
1944	5.34	7.83	5.65	17.6	19.78	29.01	20.93
1945	4.95	8.68	5.39	18.0	17.93	31.44	19.52
1946	4.63	8.31	5.21	19.5	15.48	27.79	17.42
1947	5.05	7.77	5.67	22.3	14.77	22.72	16.58
1948	5.76	8.01	6.30	24.1	15.58	21.67	17.04
1949	5.78	7.72	6.23	23.8	15.83	21.15	17.07
1950	5.56	7.28	5.94	24.1	15.04	19.70	16.07
1951	5.61	7.10	5.91	26.0	14.07	17.80	14.82
1952	5.57	7.01	5.85	26.5	13.70	17.25	14.39
1953	5.46	6.84	5.72	26.7	13.33	16.70	13.97
1954	5.41	6.76	5.66	26.9	13.11	16.38	13.72
1955	5.36	6.66	5.60	26.8	13.04	16.20	13.62
1956	5.33	6.68	5.58	27.2	12.78	16.01	13.38
1957	5.31	6.55	5.54	28.1	12.32	15.20	12.85
1958	5.64	6.46	5.80	28.9	12.72	14.57	13.09
1959	5.88	6.29	5.96	29.1	13.17	14.09	13.35
1960	6.09	6.35	6.14	29.6	13.41	13.99	13.52
1961	6.28	6.08	6.24	29.9	13.69	13.26	13.61
1962	6.45	5.87	6.31	30.2	13.93	12.67	13.62
1963	6.17	5.82	6.09	30.6	13.15	12.40	12.98
1964	6.12	5.45	5.95	31.0	12.87	11.46	12.51
1965	6.06	5.29	5.87	31.5	12.54	10.95	12.15
1966	5.83	5.16	5.67	32.4	11.73	10.38	11.41

1967	5.64	5.01	5.49	33.4	11.01	9.78	10.72
1968	5.61	4.95	5.46	34.8	10.51	9.27	10.23
1969	5.79	5.18	5.68	36.7	10.29	9.20	10.09
1970	6.00	5.01	5.79	38.8	10.08	8.42	9.73
1971	6.33	5.08	6.06	40.5	10.19	8.18	9.76
1972	6.40	4.98	6.08	41.8	9.98	7.77	9.48
1973	6.63	5.32	6.34	44.4	9.74	7.81	9.31
1974	7.52	6.39	7.29	49.3	9.95	8.45	9.64
1975	7.69	7.17	7.59	53.8	9.32	8.69	9.20
1976	8.16	7.15	7.97	56.9	9.35	8.19	9.13
1977	8.61	7.61	8.42	60.6	9.26	8.19	9.06
1978	8.49	7.49	8.29	65.2	8.49	7.49	8.29
1979	8.96	7.66	8.70	72.6	8.05	6.88	7.81
1980	11.49	8.79	10.99	82.4	9.09	6.96	8.70
1981	12.74	9.47	12.34	90.9	9.14	6.79	8.85
1982	12.02	9.57	11.77	96.5	8.12	6.47	7.95
1983	12.05	9.76	11.62	99.6	7.89	6.39	7.61
1984	12.80	9.38	12.11	103.9	8.03	5.89	7.60
1985	12.21	9.27	11.66	107.6	7.40	5.62	7.07
1986	11.08	9.63	10.93	109.6	6.59	5.73	6.50
1987	11.45	9.74	11.11	113.6	6.57	5.59	6.38
1988	12.31	10.40	11.88	118.3	6.78	5.73	6.55
1989	13.08	10.36	12.43	124.0	6.88	5.45	6.54
1990	13.43	10.83	12.76	130.7	6.70	5.40	6.37
1991	13.24	11.32	12.74	136.2	6.34	5.42	6.10
1992	12.85	11.56	12.51	140.3	5.97	5.37	5.81
1993	13.74	11.28	13.13	144.5	6.20	5.09	5.92
1994	13.12	11.18	12.65	148.2	5.77	4.92	5.57
1995	13.52	11.13	12.92	152.4	5.78	4.76	5.53
1996	13.76	10.92	13.05	156.9	5.72	4.54	5.42
1997	13.97	10.96	13.18	160.5	5.68	4.45	5.35
1998	14.08	10.38	13.11	163.0	5.63	4.15	5.24
1999	13.96	10.06	12.94	166.6	5.46	3.94	5.06
2000	14.57	10.59	13.51	172.2	5.52	4.01	5.12
2001	13.25	10.11	12.42	177.1	4.88	3.72	4.57
2002	12.00	9.86	11.45	179.9	4.35	3.57	4.15
2003	12.29	10.14	11.78	184.0	4.35	3.59	4.17
2004	12.03	10.60	11.67	188.9	4.15	3.66	4.03
2005	12.29	11.16	12.00	195.3	4.10	3.73	4.01
2006	13.02	11.93	12.73	201.6	4.21	3.86	4.12
2007	13.11	12.67	12.98	207.3	4.12	3.98	4.08
2008	13.84	13.46	13.73	215.3	4.19	4.08	4.16
2009	12.07	11.37	11.87	214.5	3.67	3.46	3.61

*Congress enacted legislation deregulating domestic airline passenger service in October 1978.

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PETROLEUM & OTHER LIQUIDS

[GLOSSARY ›](#)[FAQS ›](#)**Spot Prices**

(Crude Oil in Dollars per Barrel, Products in Dollars per Gallon)

Period: ▼

Product by Area	2005	2006	2007	2008	2009	2010	View History
Crude Oil							
WTI - Cushing, Oklahoma	56.64	66.05	72.34	99.67	61.95	79.48	1986-2010
Brent - Europe	54.57	65.16	72.44	96.94	61.74	79.61	1987-2010
Conventional Gasoline							
New York Harbor, Regular	1.565	1.823	2.062	2.451	1.665	2.095	1986-2010
U.S. Gulf Coast, Regular	1.596	1.826	2.040	2.471	1.635	2.053	1986-2010
RBOB Regular Gasoline							
Los Angeles	1.773	2.065	2.293	2.631	1.845	2.213	2003-2010
No. 2 Heating Oil							
New York Harbor	1.626	1.806	2.031	2.855	1.646	2.127	1986-2010
Ultra-Low-Sulfur No. 2 Diesel Fuel							
New York Harbor		1.968	2.152	2.976	1.699	2.198	2006-2010
U.S. Gulf Coast		1.957	2.146	2.923	1.664	2.160	2006-2010
Los Angeles	1.796	2.085	2.249	2.911	1.702	2.207	2001-2010
Kerosene-Type Jet Fuel							
U.S. Gulf Coast	1.715	1.923	2.131	2.964	1.664	2.149	1990-2010
Propane							
Mont Belvieu, Texas	0.914	1.014	1.210	1.413	0.844	1.163	1992-2010

- = No Data Reported; -- = Not Applicable; **NA** = Not Available; **W** = Withheld to avoid disclosure of individual company data.**Notes:** Weekly, monthly, and annual prices are calculated by EIA from daily data by taking an unweighted average of the daily closing spot prices for a given product over the specified time period. See Definitions, Sources, and Notes link above for more information on this table.

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Refiner Petroleum Product Prices by Sales Type

(Cents per Gallon Excluding Taxes)

Area: Period:

Show Data By:							
<input checked="" type="radio"/> Sales Type/ Product	<input type="radio"/> Area	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11
Sales to End Users							
Motor Gasoline		225	221.9	231.9	237.8	251.4	1983-2010
Aviation Gasoline		296.7	289.3	300	309.5	321.8	1983-2010
Kerosene-Type Jet Fuel		215.8	214.8	229.8	237.4	248.4	262.3 1975-2011
Propane (Consumer Grade)		121.1	128.3	142.5	NA	186.3	1983-2010
Kerosene		277.2	289.8	305.8	313	325	1983-2010
No. 1 Distillate		270.5	261.9	286.2	290.9	295.9	1983-2010
No. 2 Distillate		226.2	227	239.2	246.2	256.4	1983-2010
No. 2 Diesel Fuel		226	226.9	238.9	245.7	255.4	1983-2010
Ultra Low Sulfur		227.7	228.8	241.3	247.9	257.4	2007-2010
Low Sulfur		217.5	220.8	230.8	238.2	248.6	1994-2010
High Sulfur		224.7	224.3	228.1	239	245.3	1994-2010
No. 2 Fuel Oil		237.9	234.6	258	264.1	275	1983-2010
No. 4 Fuel		W	W	W	W	W	1983-2010
Residual Fuel Oil		167.6	164.5	172.1	180.4	193.1	1983-2010
Sulfur Less Than or Equal to 1%		189.5	188.3	191.3	202.5	221.5	1983-2010
Sulfur Greater Than 1%		157.1	155.8	163.7	170.1	178.4	1983-2010
Sales for Resale							
Motor Gasoline		209.5	208.8	219.8	224.3	238.3	1983-2010
Aviation Gasoline		284.2	280.5	289	286.8	302.4	1983-2010
Kerosene-Type Jet Fuel		213.8	213.1	226.3	234.2	245.9	259.7 1975-2011
Propane (Consumer Grade)		108.4	115.1	125.3	127.7	132.2	1983-2010
Kerosene		212.5	216.3	238.4	NA	276.6	1983-2010
No. 1 Distillate		241.2	249.4	266	273.7	287	1983-2010
No. 2 Distillate		215.5	218.6	231.8	238.5	248	1983-2010
No. 2 Diesel Fuel		216.1	219	232.5	239.2	248.6	1983-2010
No. 2 Fuel Oil		204.1	209.3	222.1	230.8	243.5	1983-2010
No. 4 Fuel		W	W	W	W	W	1983-2010
Residual Fuel Oil		164.2	163.2	171.2	176.8	186.5	1983-2010
Sulfur Less Than or Equal to 1%		170.5	171.6	179.3	186.5	203.6	1983-2010
Sulfur Greater Than 1%		162.5	161.2	168.8	174.1	181.4	1983-2010

- = No Data Reported; -- = Not Applicable; NA = Not Available; W = Withheld to avoid disclosure of individual company data.

Notes: Values shown for kerosene-type jet fuel for the current month at the U.S. and PADD levels are initial estimates calculated using prior history of the series as well as present and past values of other related time series. For all other data, values shown for the current month are preliminary. Values shown for the previous month may be revised to account for late submissions and corrections. Final revisions to monthly and annual values are available upon publication of the Petroleum Marketing Annual. Annual averages that precede the release of the Petroleum Marketing Annual are calculated from monthly data published in the Petroleum Marketing Monthly. See Definitions, Sources, and Notes link above for more information on this table.

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Field Name	Description
------------	-------------

Summaries

Passengers	On-Flight Market Passengers Enplaned	Analysis
Freight	On-Flight Market Freight Enplaned (pounds)	Analysis
Mail	On-Flight Market Mail Enplaned (pounds)	Analysis
Distance	Distance between airports (miles)	

Carrier

UniqueCarrier	Unique Carrier Code. When the same code has been used by multiple carriers, a numeric suffix is used for earlier users, for example, PA, PA(1), PA(2). Use this field for analysis across a range of years.	Analysis
AirlineID	An identification number assigned by US DOT to identify a unique airline (carrier). A unique airline (carrier) is defined as one holding and reporting under the same DOT certificate regardless of its Code, Name, or holding company/corporation.	Analysis
UniqueCarrierName	Unique Carrier Name. When the same name has been used by multiple carriers, a numeric suffix is used for earlier users, for example, Air Caribbean, Air Caribbean (1).	
UniqCarrierEntity	Unique Entity for a Carrier's Operation Region.	Analysis
CarrierRegion	Carrier's Operation Region. Carriers Report Data by Operation Region	Analysis
Carrier	Code assigned by IATA and commonly used to identify a carrier. As the same code may have been assigned to different carriers over time, the code is not always unique. For analysis, use the Unique Carrier Code.	
CarrierName	Carrier Name	
CarrierGroup	Carrier Group Code. Used in Legacy Analysis	Analysis
CarrierGroupNew	Carrier Group New	Analysis

Origin

Origin	Origin Airport	Analysis
OriginCityName	Origin Airport, City Name	
OriginCityNum	Origin City Code	
OriginCountry	Origin Airport, Country	Analysis
OriginCountryName	Origin Airport, Country Name	
OriginWac	Origin Airport, World Area Code	Analysis

Destination

Dest	Destination Airport	Analysis
DestCityName	Dest Airport, City Name	
DestCityNum	Destination City Code	
DestCountry	Destination Airport, Country	Analysis
DestCountryName	Destination Airport, Country Name	
DestWac	Destination Airport, World Area Code	Analysis

Time Period

Year	Year	
Quarter	Quarter	Analysis
Month	Month	Analysis

Other

DistanceGroup	Distance Intervals, every 500 Miles, for Flight Segment	Analysis
Class	Service Class	Analysis

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BAY AREA AIRPORT CONGESTION TRACKING SYSTEM RECOMMENDATIONS

Prepared for:
Regional Airport Planning Committee



Prepared by:
SH&E
an ICF International Company

July 2011

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1 OBJECTIVE

The Regional Airport System Plan Analysis Update (“RASPA Update”) was undertaken to assess the capability of the Bay Area airports to accommodate long-term future (2035) aviation demand. The results of the analysis indicate that airport capacity issues will lead to aggravating delays that can hinder regional economic growth and lead to adverse environmental impacts that can affect the region’s quality of life. Because there is a degree of uncertainty inherent in the long-term aviation demand forecasts assumed in the analysis, the study provides recommendations for a Forecast Tracking System to gauge how well the forecasts are tracking against actual airport activity at the primary Bay Area airports. Of similar importance is the need to understand how actual airport activity affects available runway capacity. In addition to tracking actual activity levels against the forecasts, the study also includes recommendations for a *Congestion Tracking System*. A system for monitoring congestion can be used to assess how actual airport activity levels compare to estimated airport capacity and to evaluate the severity of the delays in the system. RAPC may then use this information to inform its policies and recommendations, and the timing of such policies, and to direct efforts toward a solution.

2 RUNWAY CONGESTION TRACKING SYSTEM FRAMEWORK

The framework for the Runway Congestion Tracking system is designed to help RAPC planners answer the following critical questions:

- What is the level of runway demand at the Bay Area airports and is there adequate capacity to serve that demand?
- What is driving airport delays?
- How are delays affecting air passengers?
- Have there been any major changes within the system that may alter available runway capacity, either positively or negatively?

Answers to these questions will inform RAPC’s policy recommendations and actions for ensuring that the region’s airports can efficiently meet future air travel demand. In designing the runway congestion tracking system consideration was given to the fact that it will be carried out by RAPC staff with limited resources and access to aviation databases. The recommended tracking metrics, discussed in the following section, are primarily from publically available government data sources.

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3 RUNWAY CONGESTION TRACKING SYSTEM METRICS

3.1 WHAT IS THE CURRENT LEVEL OF RUNWAY DEMAND AND AVAILABLE CAPACITY?

Aircraft activity is the critical metric for tracking how runway demand compares to airport system capacity. It is also the main determinant of airside delays and a key metric in the Forecast Tracking System. Of upmost importance is the comparison of airport operations to the runway capacities that were estimated for each airport. This can be monitored on an annual basis by comparing annual aircraft operations to estimated annual airport capacities.

3.1.1 Aircraft Operations

Aircraft operations by individual airport, which would also be tracked in the Forecast Tracking System, are shown in Exhibit 1. These data show that runway demand for the system as a whole is down by nearly 20 percent since the study base year. However, while aircraft operations have been declining at OAK and SJC, total aircraft operations at SFO have increased by 3.8 percent.

Exhibit 1 - Total Aircraft Operations, System and by Airport – 2007 to 2010

Year	OAK	SFO	SJC	Total
2007	337,295	373,015	199,742	910,052
2008	269,631	387,710	172,576	829,917
2009	233,183	379,751	145,838	758,772
2010	219,652	387,248	123,490	730,390
Percent Change				
2008	-20.1%	3.9%	-13.6%	-8.8%
2009	-13.5%	-2.1%	-15.5%	-8.6%
2010	-5.8%	2.0%	-15.3%	-3.7%
Since 2007	-34.9%	3.8%	-38.2%	-19.7%

Sources :

2007 - *Baseline Aviation Activity Forecasts for the Primary Bay Area Airports*, August 27, 2009

2008 to 2010 - Published airport activity reports from individual airport websites.

Tracking aircraft operations by type of operator would provide insight on the types of activity that may be causing the airport to reach its capacity limits and available policy options for addressing potential capacity issues. These data may also be tracked as part of the Forecast Tracking System and are summarized in Exhibit 2.

Exhibit 2 – Aircraft Operations by Airport and by Type – 2007 to 2010

Year	Airline + Air Taxi	GA Itinerant	GA Local	Military
OAK				
2007	206,329	59,689	81,332	396
2008	177,202	49,127	46,031	1,910
2009	141,329	43,983	45,025	4,284
2010	135,941	42,658	36,591	4,460
<u>Percent Change</u>				
2008	-14.1%	-17.7%	-43.4%	382.3%
2009	-20.2%	-10.5%	-2.2%	124.3%
2010	-3.8%	-3.0%	-18.7%	4.1%
Since 2007	-34.1%	-28.5%	-55.0%	1026.3%
SFO				
2007	357,717	19,150		2,633
2008	369,557	15,478		2,675
2009	364,680	12,293		2,778
2010	371,968	12,570		2,710
<u>Percent Change</u>				
2008	3.3%	-19.2%		1.6%
2009	-1.3%	-20.6%		3.9%
2010	2.0%	2.3%		-2.4%
Since 2007	4.0%	-34.4%		2.9%
SJC				
2007	131,396	40,127	15,666	78
2008	121,250	35,599	15,654	73
2009	105,138	26,566	13,776	358
2010	92,526	26,335	4,356	273
<u>Percent Change</u>				
2008	-7.7%	-11.3%	-0.1%	-6.4%
2009	-13.3%	-25.4%	-12.0%	390.4%
2010	-12.0%	-0.9%	-68.4%	-23.7%
Since 2007	-29.6%	-34.4%	-72.2%	250.0%

Note: Airline + Air Taxi includes scheduled and non-scheduled passenger and all-cargo airline aircraft operations and some private on-demand charter conducted in business jets and small general aviation aircraft. Military includes local and itinerant operations by military controlled aircraft.

Sources :
OAK – FAA, Air Traffic Activity System (ATADS)
SFO and SJC - Published airport activity reports from individual airport websites.

As shown in Exhibit 2, all types of aircraft activity are below the Baseline 2007 levels at OAK and SJC, and local GA operations show the steepest declines. At SFO, airline activity (as shown by the Airline + Air Taxi category) is responsible for all of the growth in aircraft operations at the airport.

Data Sources

Each airport reports total aircraft operations in monthly activity reports that are published on their respective websites. The December reports provide data on a calendar year basis.

OAK: http://www.flyoakland.com/airport_stats_monthly_report.shtml

SFO: <http://www.flysfo.com/web/page/about/news/pressres/stats-2009.html>

SJC: <http://www.flysanjose.com/about.php?page=activity/activity&exp=3&subtitle=Activity+and+Financials+|+Airport+Activity>

The data reports for SFO and SJC provide a sufficient level of disaggregation to summarize aircraft operations by user category as presented in Exhibit 2. However, the activity report for OAK only contains total aircraft operations without a breakout by user category. Similar data for OAK by user category can be obtained from the FAA's Air Traffic Activity Data System (ATADS) through the following link:

FAA Air Traffic Activity System (ATADS): <http://aspm.faa.gov/opsnet/sys/Main.asp?force=atads>

3.1.2 Comparison of Annual Operations and Capacity

Once annual operations data are collected, annual runway demand can be compared to estimated annual capacity of each airport to track how close each airport may be to its respective capacity limit. The comparison for SFO is depicted in Exhibit 3, which shows annual aircraft operations compared to SFO's estimated annual capacity range of 460,000 to 485,000 annual aircraft operations. Similar charts can be constructed for OAK and SJC using the annual aircraft operations data described in Section 3.1.1 and the estimated annual capacity range for each airport. Exhibit 4 summarizes the estimated annual airport capacities, which correspond to an average aircraft delay range of 12 to 15 minutes based on the capacity and delay modeling conducted for the RASPA Update. It should be noted that the baseline capacity and delay analysis was focused solely on runway capacity and delays and did not consider airspace or landside constraints. Only airspace issues within the immediate vicinity of the airport were factored into the analysis.

Exhibit 3 – Comparison of Actual Aircraft Operations and Estimated Airport Capacity for SFO – 2007 to 2010

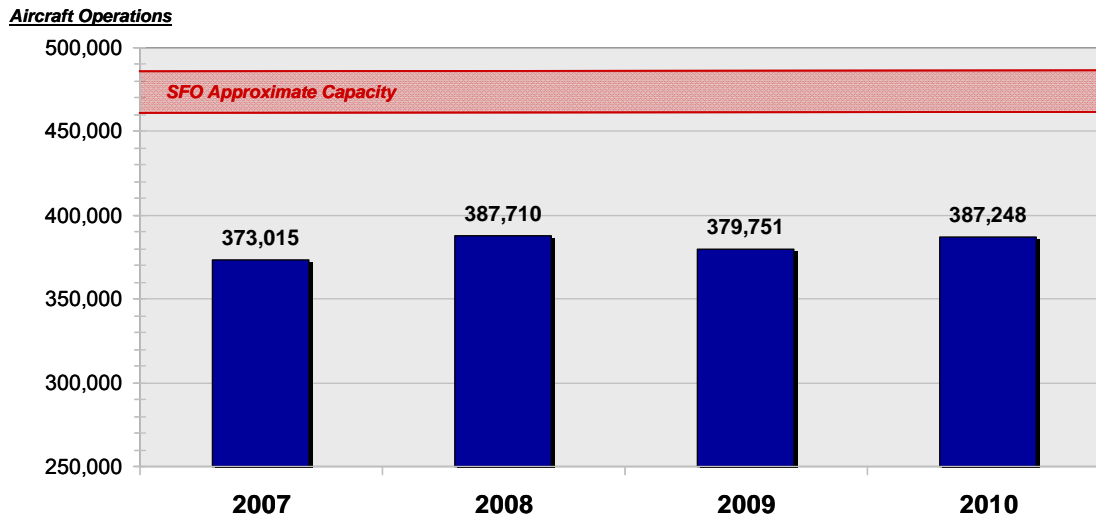


Exhibit 4 – Estimated Annual Airport Capacities

Airport	Annual Operations	
	Capacity Range	
OAK	425,000	- 450,000
SFO	460,000	- 485,000
SJC	520,000	- 550,000

Note: Based on average aircraft delays of 12 to 15 minutes.

Source: Regional Airline Planning Committee, *Baseline Capacity and Delays Report*, prepared by Flight Transportation Associates, August 2010.

3.2 WHAT IS DRIVING AIRPORT DELAYS?

Potential causes of delay include airline operating decisions such as scheduling flights beyond the airport's capacity during peak operating hours or the use of small aircraft and/or frequent flights, which could lead to inefficiencies in airport throughput. In addition to tracking annual operations against annual capacity, tracking hourly operations against estimated hourly capacities would provide an indication of potential airline over-scheduling as a contributor to delays. Critical airport efficiency metrics can also be monitored to understand changes in airline operating behavior that may affect capacity and trigger the

need for policy actions such as demand management. These include metrics such as average passengers per operation and average seats per aircraft.

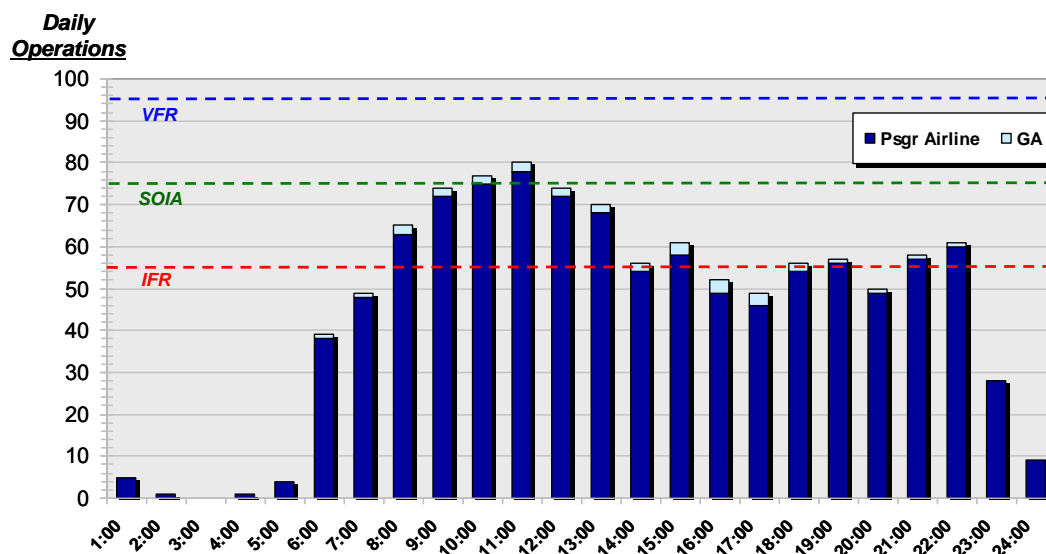
Delays at the Bay Area airports may also be caused by other airline operational issues, delays elsewhere in the airspace system, security breaches, and extreme weather conditions. These other causes of delays can be monitored by reviewing available FAA data on airport delays by possible cause.

3.2.1 Airline Scheduling

RAPC can track scheduled airline flights against estimated capacity by hour to discern whether or not airline flight schedules are contributing to delays by reaching or exceeding capacity levels in particular hours. This is especially important for SFO where demand peaks during the morning hours and demand management is a possible tool for dealing with unacceptable levels of delay.

Exhibit 5 shows how scheduled passenger airline data can be used to track hourly flight activity against hourly capacity at SFO. The analysis is based on scheduled passenger airline operations for a weekday during the month of August, which is the peak month for Bay Area air travel demand. The scheduled data has been adjusted to also reflect an average hourly distribution for general aviation activity at SFO, based on the base year 2007 hourly GA distribution used in the RASPA Update and SFO's reported GA operations for August 2010.

Exhibit 5 - Comparison of SFO's Actual Aircraft Operations and Estimated Airport Capacity by Hour - Average Weekday, August 2010



Note: Estimated capacities are for 2007.

Scheduled passenger airline operations are based on an average weekday during August 2010. GA operations are based on an average day for August 2010

Source: OAG and SFO, Monthly Data report, August 2010.

As shown in Exhibit 5, hourly activity during the peak morning period is well below the estimated VFR¹ capacity of 96 operations per hour. However, hourly activity exceeds IFR² capacity for several hours and for all hours during the morning peak from 8:00 am to 1:00 pm, which is a strong indication of morning flight delays during poor weather conditions. For two hours during the peak period, from 10:00 am to noon, activity levels even exceed the SOIA³ capacity of 76 operations per hour. The estimated hourly capacities by operating condition for each airport are summarized in Exhibit 6.

Exhibit 6 – Estimated Hourly Operating Capacities for the Primary Bay Area Airports

Airport/ Operating Condition	Operations per Hour		
	2007	2020	2035
OAK			
VFR	93	97	99
MVFR	62	63	65
IFR	54	58	59
SFO			
VFR	96	99	100
SOIA	76	79	82
IFR	56	61	61
SJC			
VFR	93	97	99
MVFR	62	63	65
IFR	54	58	59

Note: Capacities shown are for west flow conditions.

Source: Regional Airline Planning Committee, *Baseline Capacity and Delays Report*, prepared by Flight Transportation Associates, August 2010.

Data Sources

Published airline schedule data can be purchased from the Official Airline Guide or other private vendors or may be provided by the airports. GA operations for the airports can be obtained from the monthly data reports published online and described in Section 3.1.1. Hourly profiles for GA operations at each of the airports can be found in the Appendix.

¹ Under visual flight rules (VFR) conditions the weather is clear enough to allow the pilot to see where the aircraft is going. Specifically, the cloud ceiling is at or above 4,500 ft and visibility is at or above 5 nautical miles (nm).

² Under instrument flight rules (IFR) conditions, the weather is such that flight by outside visual reference is not safe and aircraft can only be flown by reference to navigation instruments in the flight deck. Specifically, the cloud ceiling is below 1,000 ft or visibility is below 3 nm.

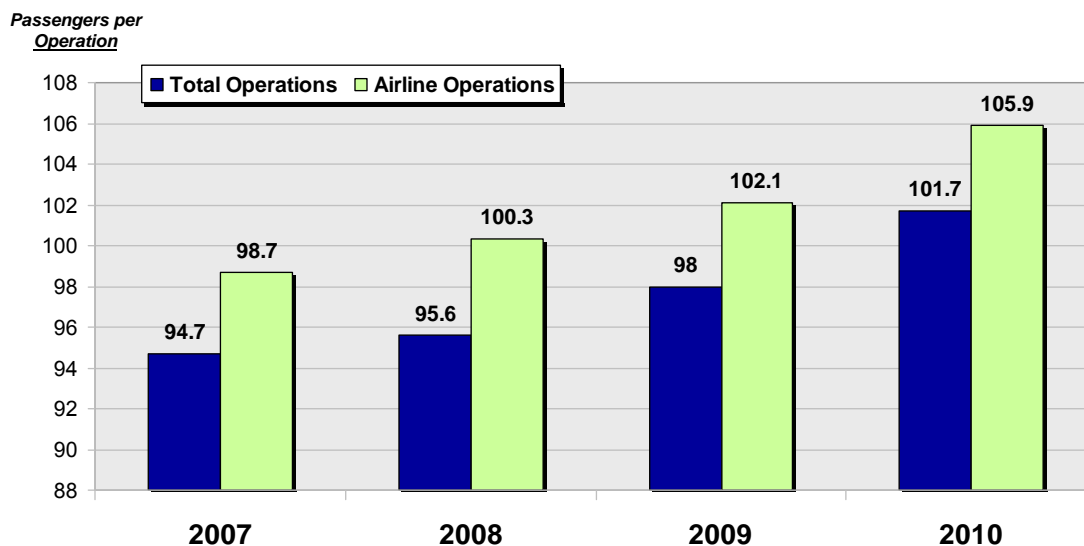
³ Simultaneous Offset Instrument Approaches (SOIA) is a particular operating configuration at SFO that permits dual arrival runway capacity on runways 28L and 28R down to weather minimums of 2,100 ft ceiling and 4 nm visibility.

3.2.2 Airport Efficiency

Average Passengers per Operation

RAPC may also track certain measures of airport efficiency. The first is average passengers per operation which measures the average throughput of the airport. This metric can easily be calculated from the annual passenger and operations data reported by the airports. Exhibit 7 shows the trend in average passengers per operation at SFO from 2007 to 2010. Average passengers per operation may be calculated using either total aircraft operations or airline operations. In either case, the trend shows an increase in passenger throughput at the airport. This may mean that passenger load factors are increasing, or the average aircraft size in service at SFO has increased, or both.

Exhibit 7 – Trend in Average Passengers per Operation at SFO, 2007 to 2010



Note: Total Operations includes passenger and cargo air carriers, commuter airlines, air-taxi, general aviation and military. Airline Operations includes passenger and cargo air carriers, commuter airlines and air-taxi.

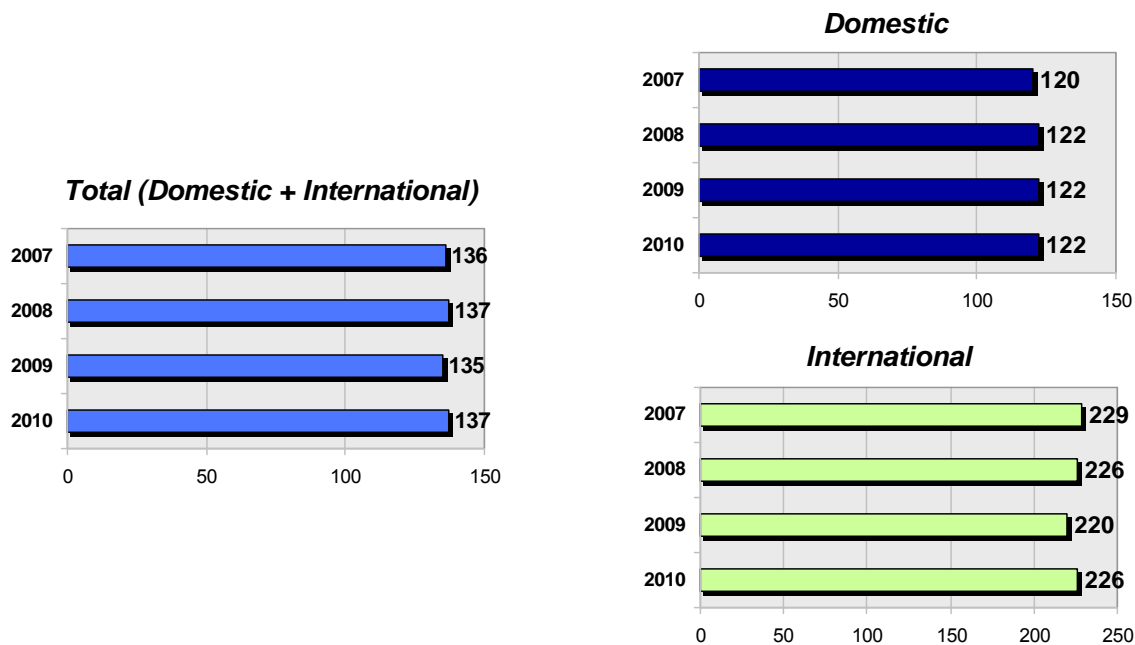
Source: SFO, Monthly Air Traffic Reports

Average Aircraft Size

Using published airline schedule data RAPC can also track the average number of seats per operation at each of the airports. This metric will provide insight into airline fleet changes that may have a positive or negative impact on airport passenger throughput. Total operations and total seats for a weekday in August can be obtained from published airline schedules and used to calculate the average number of seats per aircraft operation at each airport. Exhibit 8, which summarizes the average number of seats per operations at SFO, shows that the overall average aircraft size has remained stable from 2007 to 2010. Similarly, there has been no significant change to either the average aircraft size used for domestic services or the average aircraft size serving international markets. Since there has not been an increase in average aircraft

size for the period examined, then the increase in passenger throughput shown in Exhibit 7 is entirely due to increases in load factors (i.e., the percentage of airline seats filled with revenue paying passengers). The same data can be used to track aircraft size trends at OAK and SJC.

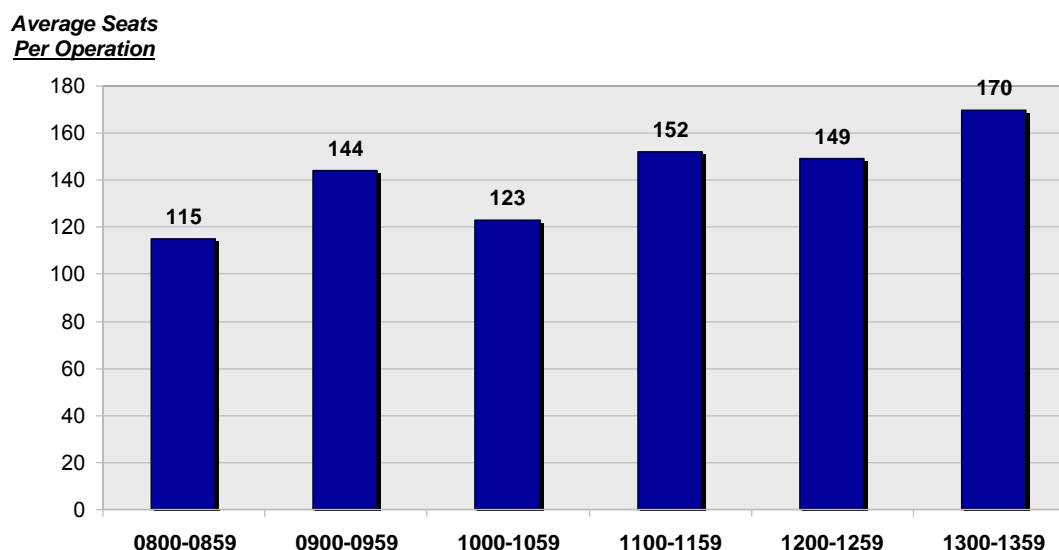
Exhibit 8 – Trend in Average Aircraft Size for Scheduled Passenger Airlines at SFO - August, 2007 to 2010



Source: OAG

For SFO, RAPC may also want to track the average aircraft size by hour during the morning/early afternoon peak period of 8:00am to 1:00pm. Tracking the average seat size for these hours could indicate whether or not the use of small aircraft is contributing to inefficiencies during this peak period. Exhibit 9 shows that during August 2010, the average aircraft size during the peak varied from 115 seats during the 8:00 am hour to 170 seats during the 1:00 pm hour. The wide variation reflects SFO's role as a connecting hub and international gateway airport. The early morning hours are characterized by more small aircraft feeder flights from small California communities that rely on SFO for connecting flights to the rest of the national air transportation system. The much higher average aircraft size at the end of the peak reflects a concentration of international arriving and departing flights during that hour.

Exhibit 9 - Average Aircraft Size for Scheduled Passenger Airlines at SFO by Hour During the Morning/Early Afternoon Peak Period – Average Weekday, August 2010



Source: OAG

Data Sources

Published airline schedule data can be purchased from the Official Airline Guide or other private vendors.

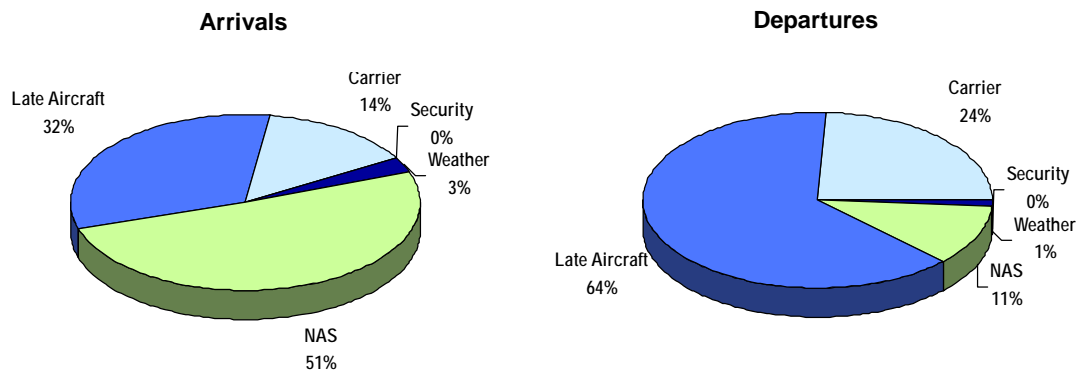
3.2.3 Other Causes of Delays

The FAA's Airline Service Quality Performance System (ASQP) provides information on minutes of delay by five possible causes: carrier, weather, national airspace system (NAS), security, and late arriving aircraft. Tracking delay minutes by reported cause could enhance RAPC's understanding of the causes of delays and provide insight into potential strategies for mitigation.

Carrier delay refers to delays that are considered to be within the control of the air carrier such as awaiting the arrival of connecting passengers or crew, bird strikes, cargo loading, catering, computer, outage-carrier equipment, crew legality (pilot or attendant rest), damage by hazardous goods, engineering inspection, fueling, handling disabled passengers, lavatory servicing, maintenance, oversales, potable water servicing, removal of unruly passenger, slow boarding or seating, stowing carry-on baggage, weight and balance delays. Late arriving aircraft delays are caused by the late arrival of an aircraft from a previous airport. NAS delay refers to delays that are within the control of the NAS and may include: non-extreme weather conditions, airport operations, heavy traffic volume, air traffic control, etc. Security delays are caused by terminal or concourse evacuations, the re-boarding of aircraft because of a security breach, inoperative screening equipment and/or long lines in excess of 29 minutes at screening areas. Weather delay only refers to delays that are caused by extreme or hazardous weather conditions forecast at or occurring at the departure or arrival airports or en-route.

Exhibit 13 summarizes the reported causes of arrival and departure delays at SFO in 2010. Timeseries data for SFO delays is contained in the Appendix. It appears from the data that delays resulting from the typical morning fog conditions at SFO are being recorded as NAS delays, which includes delays due to non-extreme weather conditions. In 2010, NAS was the reported cause of 51 percent of SFO's arrival delay and late arriving aircraft accounted for 32 percent of arrival delay minutes. In terms of departures, late arriving aircraft was cited as the cause for nearly two-thirds of SFO's departure delays, followed by carrier-caused delays at 24 percent.

Exhibit 10 – SFO Delay Minutes by Cause - 2010



Source: U.S. DOT, Bureau of Transportation Statistics, Airline On-Time Data.

Data Source

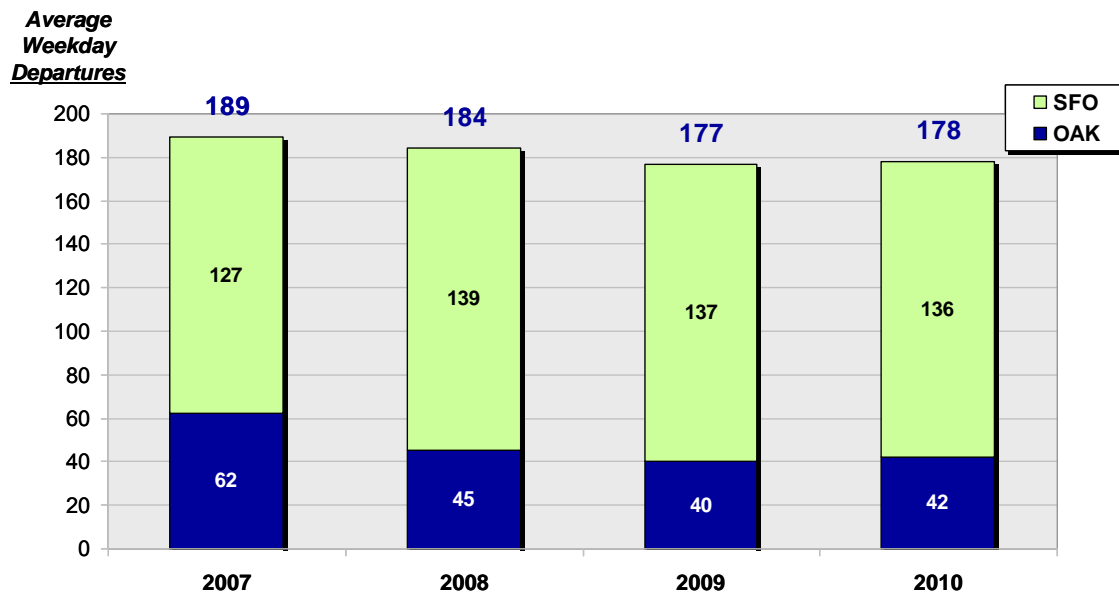
U.S. DOT Airline On-Time Statistics (downloadable data for all Bay Area airports):

http://www.transtats.bts.gov/Fields.asp?Table_ID=236

3.2.4 Airspace Interactions During Morning Departure Push

Since airspace interactions between OAK and SFO during the early morning departure push may also contribute to delays, RAPC could track the total number of SFO and OAK departures from 7:00 am to 10:00 am, to assess whether or not an increase in flights during these hours is having an impact on airport delays. These data can be obtained for a weekday in August from the published airline schedules and summarized as shown in Exhibit 10. Even though early morning departures at SFO increased between 2007 and 2010, combined early morning departures have declined by nearly 6 percent since 2007, because of a steep decline in scheduled airline activity at OAK.

Exhibit 11 – SFO and OAK Morning Departures (7:00 AM to 10:00 AM), Average Weekday August 2010



Source: OAG

Data Sources

Published airline schedule data can be purchased from the Official Airline Guide or other private vendors.

3.3 HOW ARE DELAYS AFFECTING AIR PASSENGERS?

RAPC can also monitor how delays may be affecting air passengers by tracking reported airport delays based on available data from the U.S. DOT. Key measures that should be followed include airline on-time performance at the airports, SFO's airport ranking in terms of on-time performance, and the rate of airline flight cancellations.

3.3.1 Airline On-time Performance

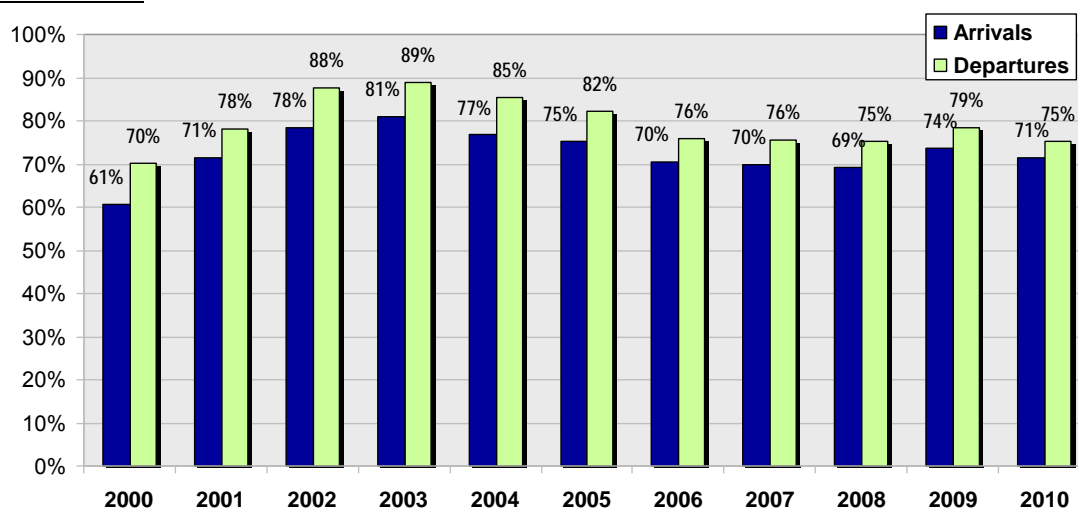
Percent of Flights Arriving/Departing On-Time

The U.S. DOT's Bureau of Transportation Statistics (BTS) publishes monthly on-time reports filed by the nation's large airlines (i.e., certified U.S. air carriers that account for at least one percent of domestic scheduled passenger revenues) with summaries of the percentage of flights arriving and departing on-time by airport. These statistics are based on the data from the FAA's Airline Service Quality Performance System (ASQP), which also reports delays by cause as described in Section 3.2.3. The popular published reports, which are often referenced in the media, only contain statistics for 29 of the largest U.S. airports, which includes SFO but excludes OAK and SJC. However, similar data for OAK and SJC can be accessed online from the BTS's TransStats portal. Flights are considered "on-time" if they depart from the gate or arrive at the gate less than 15 minutes after their scheduled departure or arrival times.

The trend in on-time performance at SFO from 2000 to 2010 is summarized in Exhibit 11. As shown, SFO's worst on-time performance over the 10-year period was in 2000 and the best performance was in 2003. In 2010, 71 percent of SFO's flights arrived on-time and 75 percent of flights departed on-time.

Exhibit 12 – Percent of Flights Arriving and Departing On-Time at SFO - 2000 to 2010

Percent On-Time

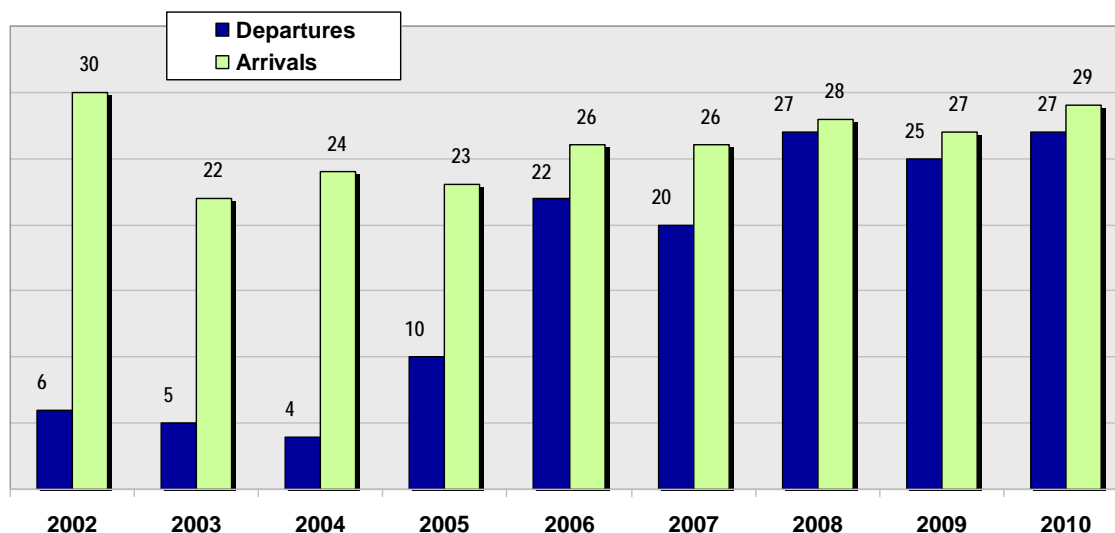


Source: U.S. DOT, Bureau of Transportation Statistics, Airline On-Time Data.

Airport Delay Ranking

It may also be useful for RAPC to understand how SFO compares to other major airports in terms of on-time flight performance. Since SFO is one of the 29 reportable airports, the U.S. DOT publishes SFO's rank among the 29 airports on a monthly basis. From the December reports, RAPC can obtain SFO's ranking for the calendar year. Exhibit 12 shows the trend in SFO's on-time performance ranking in terms of arrivals and departures with airports ranked from best (#1) to worst (#29).

Exhibit 13 – SFO's On-Time Performance Ranking Among Major U.S. Airports - 2002 to 2010



Note: The U.S. DOT reported rankings for 31 major airports in 2003-2004, 2006 and 2009; 33 airports in 2005; 32 airports in 2007 and 2008, and 29 airports in 2010

Source: U.S. DOT, Bureau of Transportation Statistics, Airline On-Time Data.

The U.S. DOT airline on-time data can be obtained online through many portals. The recommended methods of accessing the data are listed here. The second link is the easiest method for obtaining SFO's airport delay ranking.

U.S. DOT Airline On-Time Statistics (downloadable data for all Bay Area airports):

http://www.transtats.bts.gov/Fields.asp?Table_ID=236

U.S. DOT Airline On-Time Statistics (for SFO and other reportable airports only)

http://www.bts.gov/programs/airline_information/airline_ontime_tables/

3.3.2 Flight Cancellations

RAPC may also wish to monitor the rate of scheduled flight cancellations at the airports. A rise in the cancellation rate indicates deteriorating service quality and may be a sign of increasing airport congestion. Domestic scheduled and cancelled flights by airport can be obtained from the US DOT's T-100 database

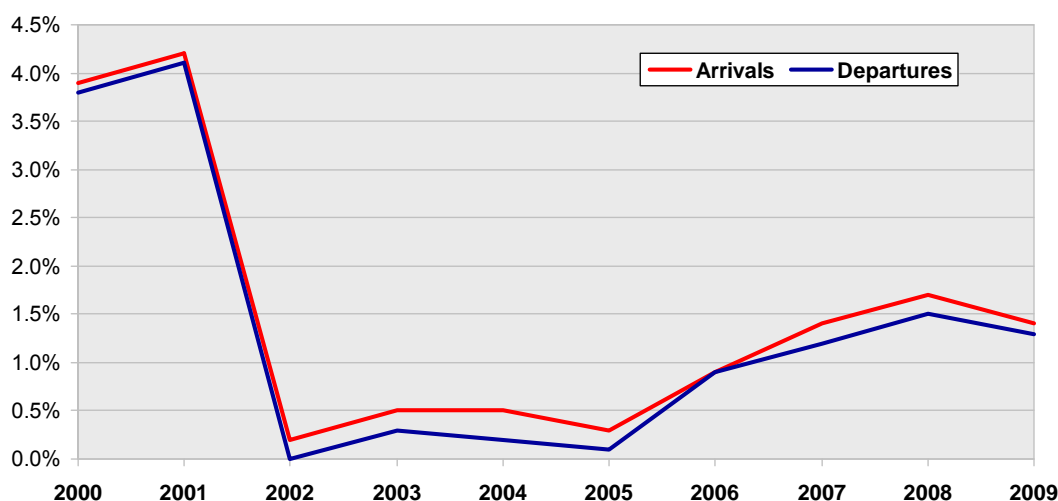
and data can be obtained separately for arriving flights and departing flights. Although the T-100 database includes activity by non-U.S. airlines, they are not required to report scheduled flights. These data provide a general indication of delays at SFO. The reasons for the cancellations would vary and could include local weather conditions at SFO, weather conditions at other airports or en-route, and delays caused by aircraft mechanical problems.

SFO's domestic passenger flight cancellation rates were calculated using the T-100 data and are summarized in Exhibit 14. SFO's cancellation rates exceeded 4 percent in 2001, but dropped to below 0.5 percent from 2002 to 2005. More recently, beginning in 2006, the cancellation rates at SFO have been on the rise with the rate of arrival cancellations reaching 1.7 percent in 2008 and then dropping slightly to 1.4 percent in 2009.

In April 2010, the FAA enacted the Three-Hour Tarmac Rule at large and medium hub airports to minimize the number of flights that are delayed on the tarmac for three hours or more. Under the regulation airlines could be fined \$27,500 per passenger for passengers on-board any flight delayed three or more hours on the ground, or as much as \$2.75 million for a plane with 100 passengers on-board. Early data on delayed and cancelled flights since the rule went into effect show some evidence that the rule has successfully reduced the number of flights delayed three or more hours, but at the same time the airlines appear to be cancelling more flights to avoid incurring the steep fines. This should be kept in mind when interpreting cancellation rates for 2010 and forward.

Exhibit 14 – Percent of Scheduled Domestic Passenger Airline Flights Cancelled at SFO, 2000 to 2009

Percent of Flights Cancelled



Source: US DOT, T-100 Database.

Data Sources

Scheduled and cancelled flights by airport can be obtained from the U.S. DOT's T-100 database.

U.S. DOT T-100 Domestic Segment:

http://www.transtats.bts.gov/Fields.asp?Table_ID=311

3.4 HAVE THERE BEEN ANY MAJOR CHANGES WITHIN THE SYSTEM THAT MAY ALTER AVAILABLE RUNWAY CAPACITY?

The baseline capacity and delay modeling assumed existing conditions as of 2007 and did not consider future airfield improvements or ATC enhancements. Therefore the capacities summarized in Exhibits 4 and 6 may change in the future as physical improvements are made at the airports, such as the relocation of the glideslope at OAK, or enhancements are made to the air traffic control system or traffic management procedures. RAPC should monitor these developments and keep them in mind when analyzing the data collected in the congestion tracking system.

3.5 AVAILABILITY OF TRACKING DATA

Most of the data required to perform the tracking is available by the end of the first quarter, as shown in Exhibit 15. If necessary, any of the delay measures that are based on the U.S. DOT's Airline On-Time Data could be monitored more frequently on a quarterly or semi-annual basis.

Exhibit 15: Data Release Dates

Metric	Source	Approximate Release of Year End Data
Traffic/Activity Measures		
Airport Passengers	Airport Statistics	Late January/February
Airport Operations	Airport Statistics	Late January/February
Airport Operations	FAA, Air Traffic Activity Data System	January
Airline Services	OAG	Available Monthly
Delay Measures		
On-Time Performance	U.S. DOT, Airline On-Time Data	February
Airport Delay Ranking	U.S. DOT, Airline On-Time Data	February
Cause of Delays	U.S. DOT, Airline On-Time Data	February
Flight Cancellation Rate	U.S. DOT, T-100 Domestic Segment	March

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OAKLAND INTERNATIONAL AIRPORT
MONTHLY ACTIVITY REPORT
CALENDAR YEAR

	DEC 10	DEC 09	INC/DEC	CY 10	CY 09	INC/DEC
PASSENGER TOTALS						
ENPLANING	400,606	414,716	-3.40%	4,769,915	4,750,185	0.42%
DEPLANING	392,794	401,513	-2.17%	4,772,418	4,755,096	0.36%
TOTAL	793,400	816,229	-2.80%	9,542,333	9,505,281	0.39%
AIRCRAFT MOVEMENTS						
TOTAL	16,608	18,408	-9.78%	219,652	233,183	-5.80%
AVIATION FUEL (GALS)						
GENERAL AVIATION	644,053	614,971	4.73%	7,544,700	7,087,316	6.45%
CONTRACT SALES	8,879,685	8,527,902	4.13%	90,034,379	96,027,124	-6.24%
TOTAL	9,523,738	9,142,873	4.17%	97,579,079	103,114,440	-5.37%
AIR MAIL (M lbs)						
MAIL IN	809	897	-9.81%	12,468	10,193	22.32%
MAIL OUT	542	912	-40.57%	7,934	8,872	-10.57%
TOTAL	1,351	1,809	-25.32%	20,402	19,065	7.01%
FREIGHT (M lbs)						
FREIGHT IN	54,818	51,800	5.83%	536,985	509,627	5.37%
FREIGHT OUT	60,185	54,588	10.25%	569,287	554,302	2.70%
TOTAL	115,003	106,388	8.10%	1,106,272	1,063,929	3.98%
AIR MAIL & FREIGHT (M lbs)						
IN	55,627	52,697	5.56%	549,453	519,820	5.70%
OUT	60,727	55,500	9.42%	577,221	563,174	2.49%
TOTAL	116,354	108,197	7.54%	1,126,674	1,082,994	4.03%
LANDED WEIGHTS (M lbs)						
PAX CARRIERS	496,189	546,296	-9.17%	6,114,587	6,415,554	-4.69%
CARGO CARRIERS	304,859	267,699	13.88%	2,612,281	2,708,730	-3.56%
TOTAL	801,048	813,995	-1.59%	8,726,868	9,124,284	-4.36%
AIRBART RIDERS						
TO AIRPORT	32,966	32,391	1.78%	354,531	363,605	-2.50%
TO BART	30,755	31,466	-2.26%	397,804	408,790	-2.69%
TOTAL REVENUE (\$)	187,035	181,010	3.33%	2,148,960	2,185,185	-1.66%
PARKING LOT						
DAILY EXITS	19,498	19,838	-1.71%	271,493	273,257	-0.65%
HOURLY EXITS	44,558	51,234	-13.03%	488,004	545,302	-10.51%
ECONOMY EXITS	9,640	9,939	-3.01%	134,818	139,517	-3.37%
VALET EXITS	0	0	NO ACT	0	11,400	NO ACTVY
TOTAL REVENUE (\$)	1,724,074	1,674,962	2.93%	23,676,901	22,684,592	4.37%
CONCESSIONS						
SHOPS	888,121	930,764	-4.58%	10,804,228	11,446,023	-5.61%
RESTAURANT/BAR	1,955,849	1,904,772	2.68%	22,100,688	21,443,659	3.06%
TOTAL REVENUE (\$)	2,843,971	2,835,536	0.30%	32,904,916	32,889,681	0.05%
CAR RENTALS REVENUE (\$)	5,347,809	5,539,378	-3.46%	79,393,104	81,795,016	-2.94%

MOVING 12 MONTH PASSENGER TOTALS

JAN 1, 2010 THRU DEC 31, 2010	9,542,333
JAN 1, 2009 THRU DEC 31, 2009	9,505,281
	0.39%

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Monthly analyses of scheduled airline traffic, including a comparative traffic report of flight operations, enplaned and deplaned passengers, cargo and U.S. mail, are available for download in PDF format. To obtain a free PDF reader, please visit the [Adobe website](#).

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Analysis of Scheduled Airline Traffic
COMPARATIVE TRAFFIC REPORT
Dec-10

San Francisco International Airport



Monthly Comparison

Calendar Year-to-Date

	Dec-10	Dec-09	% Change	2010	2009	% Change
Flight Operations - Total *	31,573	31,185	1.2%	387,248	379,751	2.0%
Air Carrier	23,755	23,517	1.0%	288,475	280,958	2.7%
Air Taxi	6,838	6,595	3.7%	83,493	83,722	-0.3%
Civil	828	925	-10.5%	12,570	12,293	2.3%
Military	152	148	2.7%	2,710	2,778	-2.4%
Revenue Landed Weight (000 lbs.)	2,348,309	2,346,379	0.1%	28,885,514	28,434,838	1.6%
Total Airport Passengers **	3,177,096	3,083,736	3.0%	39,391,234	37,453,634	5.2%
Total Enplaned & Deplaned	3,157,152	3,064,682	3.0%	39,116,764	37,224,250	5.1%
Total Enplaned	1,591,589	1,550,460	2.7%	19,539,692	18,611,271	5.0%
Total Deplaned	1,565,563	1,514,222	3.4%	19,577,072	18,612,979	5.2%
Domestic	2,469,098	2,398,450	2.9%	30,268,176	28,903,104	4.7%
Enplanements	1,244,293	1,205,993	3.2%	15,145,876	14,450,146	4.8%
Deplanements	1,224,805	1,192,457	2.7%	15,122,300	14,452,958	4.6%
International	688,054	666,232	3.3%	8,848,588	8,321,146	6.3%
Enplanements	347,296	344,467	0.8%	4,393,816	4,161,125	5.6%
Deplanements	340,758	321,765	5.9%	4,454,772	4,160,021	7.1%
Total U.S. Mail (metric tons)	4,837	6,166	-21.6%	42,545	51,836	-17.9%
Domestic	2,955	2,929	0.9%	22,437	24,608	-8.8%
International	1,882	3,238	-41.9%	20,108	27,228	-26.1%
Total Cargo *** (metric tons)	33,048	31,417	5.2%	384,179	356,266	7.8%
Domestic	9,486	13,556	-30.0%	126,981	141,246	-10.1%
International	23,562	17,861	31.9%	257,198	215,020	19.6%
Total Cargo and U.S. Mail (metric tons)	37,885	37,583	0.8%	426,724	408,102	4.6%
Cars Exited (Garage and Lot)	288,042	274,876	4.8%	3,233,408	3,158,740	2.4%

*SFO ATCT Traffic Control Count

**Total airport passengers include total enplaned and deplaned passengers and passengers who fly into and out of SFO on the same aircraft.

***Excludes mail

Analysis of Scheduled Airline Traffic
INTERNATIONAL SUMMARY REPORT
Dec-10

Monthly Comparison

	Dec-10	Dec-09	% Change
International Flight Operations	3,962	3,840	3.2%
Domestic Carriers	1,760	1,598	10.1%
Foreign Flag Carriers	2,202	2,242	-1.8%

Calendar Year-to-Date

	2010	2009	% Change
International Flight Operations	48,730	48,098	1.3%
Domestic Carriers	20,118	19,914	1.0%
Foreign Flag Carriers	28,612	28,184	1.5%

Total Airport International Passengers **	695,748	671,816	3.6%	8,945,026	8,397,816	6.5%
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Total International Enplaned and Deplaned	688,054	666,232	3.3%	8,848,588	8,321,146	6.3%
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Europe	140,715	136,125	3.4%	2,158,847	2,181,151	-1.0%
Enplanements	69,422	68,024	2.1%	1,080,551	1,096,353	-1.4%
Deplanements	71,293	68,101	4.7%	1,078,296	1,084,798	-0.6%

Asia/Middle East	342,335	336,687	1.7%	4,197,762	3,801,310	10.4%
Enplanements	175,027	175,887	-0.5%	2,064,828	1,881,184	9.8%
Deplanements	167,308	160,800	4.0%	2,132,934	1,920,126	11.1%

Australia/Oceania	44,291	41,416	6.9%	449,478	475,357	-5.4%
Enplanements	21,201	21,200	0.0%	220,214	234,419	-6.1%
Deplanements	23,090	20,216	14.2%	229,264	240,938	-4.8%

Latin America	66,425	71,618	-7.3%	743,453	705,980	5.3%
Enplanements	35,901	39,895	-10.0%	369,024	358,340	3.0%
Deplanements	30,524	31,723	-3.8%	374,429	347,640	7.7%

Canada	94,288	80,386	17.3%	1,299,048	1,157,348	12.2%
Enplanements	45,745	39,461	15.9%	659,199	590,829	11.6%
Deplanements	48,543	40,925	18.6%	639,849	566,519	12.9%

Total International Cargo & Mail (metric tons)	25,444	21,099	20.6%	277,306	242,248	14.5%
Europe	4,243	4,074	4.2%	52,707	46,049	14.5%
Asia/Middle East	19,587	16,035	22.1%	209,489	184,514	13.5%
Australia/Oceania	1,130	796	41.9%	11,240	9,858	14.0%
Latin America	421	76	453.8%	2,826	892	216.7%
Canada	63	117	-46.4%	1,045	934	11.9%

** Total airport international passengers include total enplaned and deplaned passengers and passengers who fly into and out of SFO on the same aircraft

Mineta San José International Airport - SJC

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NORMAN Y. MINETA SAN JOSÉ INTERNATIONAL AIRPORT
MONTHLY ACTIVITY REPORT FOR 12/01/2010 to 12/31/2010 (Calendar Year)

2/3/2011

	12/2010	12/2009	↑↓ (%)	YTD/2010	YTD/2009	↑↓ (%)
Passengers						
O&D Dom. - Enplane	336,990	325,532	3.5%	3,953,775	3,973,184	-0.5%
O&D Dom. - Deplane	328,195	316,325	3.8%	3,965,693	3,992,915	-0.7%
O&D Intl. - Enplane	7,161	4,650	54.0%	69,995	56,238	24.5%
O&D Intl. - Deplane	5,484	6,942	-21.0%	65,427	59,651	9.7%
Connect Enplane	9,201	9,349	-1.6%	95,587	119,881	-20.3%
Connect Deplane	9,201	9,349	-1.6%	95,587	119,881	-20.3%
	696,232	672,147	3.6%	8,246,064	8,321,750	-0.9%
Passengers - Total						
Enplaned	353,352	339,531	4.1%	4,119,357	4,149,303	-0.7%
Deplaned	342,880	332,616	3.1%	4,126,707	4,172,447	-1.1%
	696,232	672,147	3.6%	8,246,064	8,321,750	-0.9%
MAIL/FREIGHT/CARGO (lbs.)						
Mail	121,513	245,582	-50.5%	3,862,551	1,712,796	125.5%
Freight	448,299	522,555	-14.2%	5,178,207	5,658,771	-8.5%
Intl. Cargo	0	17,095	-100.0%	0	162,658	-100.0%
Domestic Cargo	9,483,784	11,748,624	-19.3%	89,684,540	111,408,337	-19.5%
	10,053,596	12,533,856	-19.8%	98,725,298	118,942,562	-17.0%
Traffic Operations						
Passenger Carrier	6,076	6,170	-1.5%	73,586	80,232	-8.3%
Taxi/Commuter	1,432	1,530	-6.4%	16,956	22,542	-24.8%
Subtotal Passenger Operations	7,508	7,700	-2.5%	90,542	102,774	-11.9%
Cargo Carrier	210	222	-5.4%	1,984	2,364	-16.1%
Military	19	21	-9.5%	273	358	-23.7%
GA Local	229	148	54.7%	4,356	13,776	-68.4%
GA Itinerant	1,862	1,736	7.3%	26,335	26,566	-0.9%
	9,828	9,827	0.0%	123,490	145,838	-15.3%
Landed Wgts (1000 lbs.)						
PAX Carrier	398,317	396,894	0.4%	4,772,056	5,165,466	-7.6%
Taxi/Commuter	38,953	40,578	-4.0%	451,972	550,068	-17.8%
Cargo Carrier	33,360	35,820	-6.9%	311,225	371,981	-16.3%
	470,630	473,292	-0.6%	5,535,252	6,087,515	-9.1%
AV Fuel (gal.)						
Retail AV Gas	3,957	4,613	-14.2%	66,316	65,204	1.7%
Retail Jet	621,067	544,776	14.0%	7,961,422	7,047,968	13.0%
Contract Jet	4,985,519	4,456,620	11.9%	57,273,020	57,745,398	-0.8%
	5,610,542	5,006,009	12.1%	65,300,758	64,858,570	0.7%
Parking						
Hourly Exits	84,027	72,809	15.4%	842,910	835,268	0.9%
Daily Exits	13,975	14,864	-6.0%	201,577	213,178	-5.4%
	98,002	87,673	11.8%	1,044,487	1,048,446	-0.4%
Taxicab Operations						
Taxi Trips	20,094	20,412	-1.6%	287,009	276,206	3.9%
PFC Revenue (prev. month)						
November ,10	1,291,716	1,168,973	10.5%	15,960,269	15,958,520	0.0%
MOVING 12 MONTH PASSENGER TOTALS (Combined)						
Jan thru Dec				8,246,064	8,321,750	-0.9%

NOTES:

- 1) YTD information adjusted to include late reporting and/or revisions to prior period
- 2) All figures are month-end activity as reported by airlines and other tenants at San Jose Intl.

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Average Daily Hourly Distribution of General Aviation Aircraft Operations

Hour	OAK	SFO	SJC
0	1.3%	1.2%	0.2%
1	1.8%	0.9%	0.1%
2	1.4%	0.6%	0.1%
3	1.7%	0.6%	0.0%
4	1.6%	0.4%	0.1%
5	2.3%	0.8%	0.2%
6	4.2%	1.6%	1.9%
7	3.9%	3.1%	6.9%
8	4.5%	5.0%	5.9%
9	3.9%	5.8%	7.0%
10	5.1%	6.4%	10.2%
11	5.8%	6.4%	5.9%
12	5.7%	7.1%	5.5%
13	5.5%	7.3%	5.6%
14	6.6%	7.4%	5.9%
15	6.9%	7.9%	6.7%
16	8.1%	8.2%	11.2%
17	6.4%	7.9%	8.5%
18	8.5%	6.6%	4.0%
19	4.8%	4.7%	5.6%
20	3.5%	3.5%	3.0%
21	2.9%	2.8%	1.7%
22	2.2%	2.4%	2.6%
23	1.2%	1.6%	1.0%
Total	100.0%	100.0%	100.0%

Source: Processed 2007 radar data.



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Field Name	Description
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Summaries

*OnTimeArrivalPct	Percent of flights that arrive on time. For percent of on time arrivals at specific airports, click Analysis . Note: If you select Origin as a category, you get percent of flights that depart from those airports and arrive on time.	Analysis
*OnTimeDeparturePct	Percent of flights that depart on time. For percent of on time departures at specific airports, click Analysis . Note: If you select Dest as a category, you get percent of flights that depart on time and arrive at those airports.	Analysis

Time Period

Year	Year	
Quarter	Quarter (1-4)	Analysis
Month	Month	Analysis
DayofMonth	Day of Month	
DayOfWeek	Day of Week	Analysis
FlightDate	Flight Date (yyyymmdd)	

Airline

UniqueCarrier	Unique Carrier Code. When the same code has been used by multiple carriers, a numeric suffix is used for earlier users, for example, PA, PA(1), PA(2). Use this field for analysis across a range of years.	Analysis
AirlineID	An identification number assigned by US DOT to identify a unique airline (carrier). A unique airline (carrier) is defined as one holding and reporting under the same DOT certificate regardless of its Code, Name, or holding company/corporation.	Analysis
Carrier	Code assigned by IATA and commonly used to identify a carrier. As the same code may have been assigned to different carriers over time, the code is not always unique. For analysis, use the Unique Carrier Code.	
TailNum	Tail Number	
FlightNum	Flight Number	

Origin

Origin	Origin Airport	Analysis
OriginCityName	Origin Airport, City Name	
OriginState	Origin Airport, State Code	Analysis
OriginStateFips	Origin Airport, State Fips	Analysis
OriginStateName	Origin Airport, State Name	
OriginWac	Origin Airport, World Area Code	Analysis

Destination

Dest	Destination Airport	Analysis
DestCityName	Destination Airport, City Name	
DestState	Destination Airport, State Code	Analysis
DestStateFips	Destination Airport, State Fips	Analysis
DestStateName	Destination Airport, State Name	
DestWac	Destination Airport, World Area Code	Analysis

Departure Performance

CRSDepTime	CRS Departure Time (local time: hhmm)	
DepTime	Actual Departure Time (local time: hhmm)	
DepDelay	Difference in minutes between scheduled and actual departure time. Early departures show negative numbers.	Analysis
DepDelayMinutes	Difference in minutes between scheduled and actual departure time. Early departures set to 0.	Analysis
DepDel15	Departure Delay Indicator, 15 Minutes or More (1=Yes)	Analysis

DepartureDelayGroups	Departure Delay intervals, every (15 minutes from <-15 to >180)	Analysis
DepTimeBlk	CRS Departure Time Block, Hourly Intervals	Analysis
TaxiOut	Taxi Out Time, in Minutes	Analysis
WheelsOff	Wheels Off Time (local time: hhmm)	
Arrival Performance		
WheelsOn	Wheels On Time (local time: hhmm)	
TaxiIn	Taxi In Time, in Minutes	Analysis
CRSArrTime	CRS Arrival Time (local time: hhmm)	
ArrTime	Actual Arrival Time (local time: hhmm)	
ArrDelay	Difference in minutes between scheduled and actual arrival time. Early arrivals show negative numbers.	Analysis
ArrDelayMinutes	Difference in minutes between scheduled and actual arrival time. Early arrivals set to 0.	Analysis
ArrDel15	Arrival Delay Indicator, 15 Minutes or More (1=Yes)	Analysis
ArrivalDelayGroups	Arrival Delay intervals, every (15-minutes from <-15 to >180)	Analysis
ArrTimeBlk	CRS Arrival Time Block, Hourly Intervals	Analysis
Cancellations and Diversions		
Cancelled	Cancelled Flight Indicator (1=Yes)	Analysis
CancellationCode	Specifies The Reason For Cancellation	Analysis
Diverted	Diverted Flight Indicator (1=Yes)	Analysis
Flight Summaries		
CRSElapsedTime	CRS Elapsed Time of Flight, in Minutes	Analysis
ActualElapsedTime	Elapsed Time of Flight, in Minutes	Analysis
AirTime	Flight Time, in Minutes	Analysis
Flights	Number of Flights	Analysis
Distance	Distance between airports (miles)	Analysis
DistanceGroup	Distance Intervals, every 250 Miles, for Flight Segment	Analysis
Cause of Delay (Data starts 6/2003)		
CarrierDelay	Carrier Delay, in Minutes	Analysis
WeatherDelay	Weather Delay, in Minutes	Analysis
NASDelay	National Air System Delay, in Minutes	Analysis
SecurityDelay	Security Delay, in Minutes	Analysis
LateAircraftDelay	Late Aircraft Delay, in Minutes	Analysis
Gate Return Information at Origin Airport (Data starts 10/2008)		
FirstDepTime	First Gate Departure Time at Origin Airport	
TotalAddGTime	Total Ground Time Away from Gate for Gate Return or Cancelled Flight	Analysis
LongestAddGTime	Longest Time Away from Gate for Gate Return or Cancelled Flight	Analysis
Diverted Airport Information (Data starts 10/2008)		
DivAirportLandings	Number of Diverted Airport Landings	Analysis
DivReachedDest	Diverted Flight Reaching Scheduled Destination Indicator (1=Yes)	Analysis
DivActualElapsedTime	Elapsed Time of Diverted Flight Reaching Scheduled Destination, in Minutes. The ActualElapsedTime column remains NULL for all diverted flights.	Analysis
DivArrDelay	Difference in minutes between scheduled and actual arrival time for a diverted flight reaching scheduled destination. The ArrDelay column remains NULL for all diverted flights.	Analysis
DivDistance	Distance between scheduled destination and final diverted airport (miles). Value will be 0 for diverted flight reaching scheduled destination.	Analysis
Div1Airport	Diverted Airport Code1	
Div1WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code1	
Div1TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code1	
Div1LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code1	
Div1WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code1	
Div1TailNum	Aircraft Tail Number for Diverted Airport Code1	
Div2Airport	Diverted Airport Code2	

Div2WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code2
Div2TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code2
Div2LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code2
Div2WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code2
Div2TailNum	Aircraft Tail Number for Diverted Airport Code2
Div3Airport	Diverted Airport Code3
Div3WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code3
Div3TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code3
Div3LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code3
Div3WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code3
Div3TailNum	Aircraft Tail Number for Diverted Airport Code3
Div4Airport	Diverted Airport Code4
Div4WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code4
Div4TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code4
Div4LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code4
Div4WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code4
Div4TailNum	Aircraft Tail Number for Diverted Airport Code4
Div5Airport	Diverted Airport Code5
Div5WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code5
Div5TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code5
Div5LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code5
Div5WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code5
Div5TailNum	Aircraft Tail Number for Diverted Airport Code5


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Additional on-time information can be found in the Air Travel Consumer Report, <http://airconsumer.ost.dot.gov/reports/index.htm>

2011	2010	2009	2008	2007	2006	2005	2004	2003
January	January	January	January	January	January	January	January	
	February	February	February	February	February	February	February	
	March	March	March	March	March	March	March	
	April	April	April	April	April	April	April	
	May	May	May	May	May	May	May	
	June	June	June	June	June	June	June	
	July	July	July	July	July	July	July	
	August	August	August	August	August	August	August	
	September	September	September	September	September	September	September	September
	October	October	October	October	October	October	October	October
	November	November	November	November	November	November	November	November
	December	December	December	December	December	December	December	December

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Field Name	Description
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Summaries

DepScheduled	Departures Scheduled	Analysis
DepPerformed	Departures Performed	Analysis
Payload	Available Payload (pounds)	Analysis
Seats	Available Seats	Analysis
Passengers	Non-Stop Segment Passengers Transported	Analysis
Freight	Non-Stop Segment Freight Transported (pounds)	Analysis
Mail	Non-Stop Segment Mail Transported (pounds)	Analysis
Distance	Distance between airports (miles)	
*LoadFactor	Load Factor: Ratio of Passenger Miles to Available Seat Miles	Analysis
RampTime	Ramp to Ramp Time (minutes)	Analysis
AirTime	Airborne Time (minutes)	Analysis

Carrier

UniqueCarrier	Unique Carrier Code. When the same code has been used by multiple carriers, a numeric suffix is used for earlier users, for example, PA, PA(1), PA(2). Use this field for analysis across a range of years.	Analysis
AirlineID	An identification number assigned by US DOT to identify a unique airline (carrier). A unique airline (carrier) is defined as one holding and reporting under the same DOT certificate regardless of its Code, Name, or holding company/corporation.	Analysis
UniqueCarrierName	Unique Carrier Name. When the same name has been used by multiple carriers, a numeric suffix is used for earlier users, for example, Air Caribbean, Air Caribbean (1).	
UniqCarrierEntity	Unique Entity for a Carrier's Operation Region.	Analysis
CarrierRegion	Carrier's Operation Region. Carriers Report Data by Operation Region	Analysis
Carrier	Code assigned by IATA and commonly used to identify a carrier. As the same code may have been assigned to different carriers over time, the code is not always unique. For analysis, use the Unique Carrier Code.	
CarrierName	Carrier Name	
CarrierGroup	Carrier Group Code. Used in Legacy Analysis	Analysis
CarrierGroupNew	Carrier Group New	Analysis

Origin

Origin	Origin Airport	Analysis
OriginCityName	Origin City	
OriginCityNum	Origin City Code	
OriginState	Origin State Code	Analysis
OriginStateFips	Origin State FIPS (U.S. Federal Information Processing Standard Codes)	Analysis
OriginStateName	Origin Airport, State Name	
OriginWac	Origin Airport, World Area Code	Analysis

Destination

Dest	Destination Airport	Analysis
DestCityName	Destination City	
DestCityNum	Destination City Code	
DestState	Destination State Code	Analysis
DestStateFips	Destination State FIPS (U.S. Federal Information Processing Standard Codes)	Analysis
DestStateName	Destination Airport, State Name	

DestWac	Destination Airport, World Area Code	Analysis
Aircraft		
AircraftGroup	Aircraft Group	Analysis
AircraftType	Aircraft Type	Analysis
AircraftConfig	Aircraft Configuration	Analysis
Time Period		
Year	Year	
Quarter	Quarter	Analysis
Month	Month	Analysis
Other		
DistanceGroup	Distance Intervals, every 500 Miles, for Flight Segment	Analysis
Class	Service Class	Analysis
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MEMORANDUM

To: Chris Brittle / MTC

Date: May 24, 2011

From: David Hollander

CC: John Yarnish / URS

Subject: Conceptual Cost Estimates for Accommodating Air Services at the Alternative Airports

1.1 INTRODUCTION

The overall goals of the Regional Aviation System Planning Update (RASP Study) are to determine when the Bay Area's primary commercial airports—Oakland International (OAK), San Francisco International (SFO), and San Jose International (SJC)—will reach their capacity limits, and to identify strategies other than new runway construction that will be most effective in allowing the region to accommodate future growth in aviation demand. A Screening Analysis evaluated the effectiveness of six specific strategies for accommodating the region's future demand. One of the alternatives involves the expansion or introduction of new airline service at secondary Bay Area airports, specifically Sonoma County Airport, which currently supports a limited number of scheduled commercial airline services, Buchanan Airfield and Travis Air Force Base.

URS was asked to prepare conceptual costs estimates for upgrading landside and airside facilities at each of the airports to accommodate the 2035 forecast passenger levels at each airport. In the screening analysis each airport was forecast to accommodate approximately 1 million passengers in 2035, which includes new passenger diversion from the primary airports (OAK, SFO and SJC) as well as growth in existing passengers in the case of Sonoma County Airport, and passengers diverted from Sacramento International Airport, in the case of Travis AFB.¹

To prepare the cost estimates, URS reviewed available airport planning documents including:

- November 2007 Draft Final Charles M. Schulz-Sonoma County Airport Master Plan Update
- October 2008 Final Buchanan Field Airport (CCR) Master Plan Update
- July 1976 Travis AFB Joint Use Feasibility Study

¹ The screening analysis estimated that the three secondary airports could potentially divert up to 2.6 million passengers from the primary airports in 2035.

1.2 SUMMARY COST ESTIMATES

The development costs for facilities to accommodate the forecast airline passengers and aircraft operations are estimated at approximately \$38-\$39 million for each airport. These costs include the construction of passenger terminal buildings, apron areas for aircraft parking, and automobile parking facilities to accommodate passengers, employees and rental cars. Terminal building costs account for 83%-87% of total estimated costs.

Estimated Airport Facilities Costs (in millions)

Facilities	Sonoma County Airport	Buchanan Field Airport	Travis AFB
Terminal Building	\$33.4 ¹	\$32.5	\$32.0
Aircraft Apron	\$1.0	\$1.0	\$0.9
Passenger Parking	\$3.9	\$5.8	\$5.7
Total	\$38.2	\$39.3	\$38.7

¹ The Sonoma County Airport Master Plan Update estimated \$22.3M in construction costs for a 48,500 sq. ft. terminal building compared to the URS estimate of \$24.6M for construction costs for a 51,000 sq. ft. terminal building. As described below, the URS estimate of \$33.4M includes design, contingency and taxes in addition to construction costs.

Certain potential improvements that may be required to support the new or expanded air services at the three secondary Bay Area airports are not reflected in these cost estimates due to the uncertainty regarding specific terminal locations, site layout and conditions. These include access taxiways, apron taxi lanes, and potential ground access improvements. As a result, the cost estimates presented in the above table may represent a lower bound on the full development costs that may be required at the individual airports.

1.3 ASSUMPTIONS

1.3.1 Terminal Facilities

At the Sonoma County Airport there is an existing 7,600 square foot passenger terminal. The current Master Plan Update anticipates that future passenger growth would trigger the development of a new terminal building, which would be constructed north of the existing building. In this analysis, URS

assumed that the 2035 forecast passenger level would trigger the construction of the new terminal building and that the new terminal would replace the existing terminal building.

Neither Buchanan Field nor Travis has an area established for passenger service and none has been identified in master plans, but general locations for passenger terminal buildings were identified in previous studies or from RAPC's discussion with airport planners. The URS analysis assumed that specific terminal sites would be determined at a future date. Therefore, the cost estimates presented do not include any costs associated with site conditions beyond a broad assumption regarding utility extension and other minor considerations.

URS made several assumptions regarding peak period passenger and aircraft activity in order to estimate terminal space requirements:

- Forecast passengers were divided by 2 to estimate annual enplaned passengers.
- Peak month passengers were assumed to average approximately 9% of annual passenger demand.
- Average day peak month (ADPM) passengers were estimated by dividing peak month passengers by 31.
- Peak hour passengers were estimated at 15% of average day passengers based on observations at similar airports.
- Peak hour aircraft operations were based on peak hour passenger levels, the projected aircraft capacity (i.e., 70 seats), and a 90% average peak hour passenger load factor.

The cost estimates also conservatively assumed that the passenger terminals would require space for up to three airlines based on approximately 500,000 annual enplanements. All aircraft boarding was assumed to be ground-level boarding without loading bridges. Estimates regarding space requirements for airport administration offices within the terminal were based on URS's professional judgment.

All costs estimates include a category labeled "other", which accounts for site differences and contingency items that are unknowable at this stage. These costs were estimated 15% of project costs (excluding taxes and estimated design costs). All estimates include a provision for state and local sales taxes based on the California Board of Equalization – Tax Rates effective April 2011. The assumed tax rates are: Sonoma County 9.50%; Buchanan Field (Concord) 9.75%; and Travis AFB (Fairfield) 8.37%.

The following sections outline the major assumptions underlying the terminal construction, apron area, and automobile parking area estimates.

1.3.2 Terminal Construction Costs

URS estimated terminal construction costs using an average cost per square foot estimate of \$450 derived from recent projects completed by URS. The assumed cost per square foot is an average and it applies to all space, including finished and unfinished areas. The terminal building estimates include costs for certain known equipment needs such as ticket counters, passenger screening devices, baggage screening equipment, etc. Costs for other equipment such as ticket kiosks, airline podia gear, etc. were not included.

1.3.3 Aircraft Apron Costs

Based on the master plan for Sonoma County it was assumed that two aircraft parking positions were available in the terminal area and two additional positions would be required. At both Buchanan and Travis it was assumed that new terminal apron would be constructed. Depending on the ultimate location for a passenger terminal, apron area may already be available. The estimated area and construction costs for aircraft parking does not include any access taxiways or on apron taxi lanes that may ultimately be required. These are highly dependent on the site layout and cannot be adequately planned at this time.

1.3.4 Automobile Parking Costs

Automobile parking requirements were calculated using standard planning tools based on the forecast annual passenger levels. At Sonoma County it was assumed that existing parking spaces would continue to be available. At both Buchanan and Travis it was assumed that new parking lots would be constructed. No provisions or assumptions have been made to account for access improvements at any of the airports. If passenger growth occurs at the levels shown, some improvements may be necessary.

Passenger Terminal Building Square Foot Assumptions

	Sonoma County	Buchanan	Travis	
Activity Levels				
Annual Passengers from MTC Study	1,025,034	1,127,120	1,105,463	Information from SH&E forecast
Annual Passengers - Base	181,848	10	-	Number of current passengers as recorded in TAF
Total Annual Passengers	1,206,882	1,127,130	1,105,463	Total of MTC study passengers plus the existing passenger levels. This number does not nclude the forecast passenger levels as found in the master plan.
Annual Enplaned Passengers	603,441	563,565	552,732	Total annual passengers divide by 2
Peak Month Passengers	54,310	50,721	49,746	9% of annual enplanements are assumed to occur during the peak month
ADPM	1,752	1,636	1,605	Peak month divided by 31
Peak Hour Enplaned Passengers	263	245	241	15% of the average day.
Annual Airline Operations	19,524	21,469	21,056	Information from SH&E forecast
Peak Hour Operations	4	4	4	Assume 90% load factor during the peak hour.
Critical/Design Aircraft	Q-400/CRJ	Q-400/CRJ	Q-400/CRJ	Information from SH&E
No of Seats Per Aircraft	70	70	70	Information from SH&E
Departure Processing				
Ticket Counter Positions	12	12	12	Assumes space for three airlines with four agent positions per airline
Ticket Counter Frontage (lf)	63	63	63	Each agent requires 48 inches and every two positions share a 30 inch bagwell
Ticket Counter Area (non-public) (sf)	630	630	630	Area includes the ticket counter surface plus work area behind the counter. Total depth is 10 feet
Ticket Lobby - Circulation & Queuing (sf)	2,670	2,556	2,525	Assumes that 50% of the passengers will need the ticket counter access. The remainder will arrive at the airport with boarding passes and/or use an electronic kiosk. Space needs to accomodate peak 20 minute period (50% of peak hour).
Ticket Kiosks (sf)	180	180	180	Assume 3 kiosks per airline. 3 airlines equals 9 kiosks times 20 SF for each equals 180 SF. Kiosks may be used at ticket agent positions.
Ticket Lobby - Seating (sf)	400	383	379	Some seating area for families and non-travelers (15% of total lobby space
Restrooms (sf)	650	650	650	Assumes restroom facilities in the non-secure area of the terminal. Space allows for men's and woman's toilets as well as for a family facility.
ATO & Airline Operations (sf)	1,260	1,260	1,260	Assumes that offices and other facilities will be provided behind the ticket counter with a depth of 20 feet.
Outbound Bag Screening (sf)	6,500	6,500	6,500	Recommended area based on centralized bag screening and three CT-80 devices with room for personnel and processing
Total Departure Processing (sf)	12,290	12,159	12,123	
Security Screening				
Number of Screening Lanes	3	3	3	Number of lanes is based on airlines' peak hour departures schedule, anticipated arrival pattern of passengers, optimal TSA staffing, and an objective of limiting passenger wait time to 10 minutes. Screening rate is 95-100 pax per hour.
Passenger Screening Area (sf)	2,905	2,713	2,660	Average 1,050 SF per lane, to include seating-composure area, Response Corridor, law enforcement officer, and private search room(s). Per TSA design standards.
Passenger Queue Area (sf)	526	491	481	Based on 16 SF per passenger in queue and optimal TSA staffing. Queue size is based on load factor, peak hour pax, screening rate.
TSA Offices/Support Space (sf)	1,000	1,000	1,000	TSA office space based on experience at other airports
Total Security Screening	4,430	4,203	4,142	

Passenger Terminal Building Square Foot Assumptions (continued)

Gate Holdroom Facilities				
Passenger Holdroom (sf)	3,624	3,385	3,320	Assume 80-percent of peak hour passengers in holdroom with 80-percent seated. 18.3 SF per seat, 15-percent standing times 13 SF per standee.
Circulation (sf)	725	677	664	Assume 20% of total holdroom area
Podium - queuing - exit corridor	1,200	1,200	1,200	250 SF for each podium including queuing space; 150 SF for exit corridor.
Restrooms (sf)	600	600	600	Assumes restroom facilities in the secure area of the terminal. Space allows for men's and woman's toilets as well as for a family facility.
Total Gate Holdroom	6,149	5,862	5,784	
Concessions and Services				
Food Concessions (sf)	2,500	2,500	2,500	Allowance for concessions based on terminal planning guidelines
Vending Machines (sf)	200	200	200	Allowance for concessions based on terminal planning guidelines
Total Concessions and Services	2,700	2,700	2,700	
Arrivals Processing				
Waiting Lobby/Greeters Area (sf)	1,443	1,347	1,321	Assume space for people waiting for arriving passengers in non-secure area -30-percent of peak hour passengers 18.3 SF per seat.
Inbound Baggage Ops (non-public) (sf)	2,500	2,500	2,500	17 FT wide roadway plus 3 FT wide offload zone plus 4 FT wide conveyor belt plus 1 FT structure equals 25 FT wide overall. Length equals 100 FT of input conveyor and oversize claim frontage.
Baggage Claim Lobby (sf)	5,913	5,522	5,416	Includes claim device, a 12 FT wide retrieval zone around device, access to oversize claim zone, and access to circulation.
Baggage Claim Frontage (lf)	493	460	451	Based on a single 70-passenger flight, average of 50% of the passenger's carrying a bag, average of 1.5 bags per passenger, 2.5 feet spacing on claim device, and 75-percent of bags displayed equals 340 LF. Accommodates claim activity for one flight at a time.
Total Arrivals Processing	9,855	9,369	9,237	
Car Rental Facilities				
Car Rental Counters (lf)	40	40	40	4 tenant spaces 10. FT
Car Rental Counters Area (sf)	400	400	400	Area includes the counter surface plus work area behind the counter. Total depth is 10 feet
Car Rental Offices (sf)	400	400	400	4 tenants, each with office space behind the counter
Queuing Area (sf)	60	60	60	Space for 3 to 4 people queueing at each counter
Total Car Rental Facilities	860	860	860	
Airport Administration and Maintenance				
Airport Offices (sf)	500	500	500	Estimated space for airport manager and staff - reception area, 3 offices and a conference room.
Loading Dock and Dumpster (sf)*	200	200	200	
Total Admin and Storage	700	700	700	
Area Subtotal (sf):				
Mechanical/Electrical/Telecomm. (+ 10%)	3,698	3,585	3,555	
Building Support and Storage (10%)	3,698	3,585	3,555	
General Circulation (+ 15%)	5,548	5,378	5,332	
Building Structure (+ 3%)	1,110	1,076	1,066	
Total	14,054	13,624	13,508	
Total Passenger Terminal Area (sf):				
	51,039	49,478	49,054	

Passenger Terminal Cost Assumptions

	Sonoma County		Buchanan		Travis		Cost/Square Foot
Departure Processing							
Ticket Counter Area (non-public) (sf)	\$	283,500	\$	283,500	\$	283,500	450
Ticket Lobby - Circulation & Queuing (sf)	\$	1,201,298	\$	1,150,016	\$	1,136,084	450
Ticket Kiosks (sf)	\$	81,000	\$	81,000	\$	81,000	450
Ticket Lobby - Seating (sf)	\$	180,195	\$	172,502	\$	170,413	450
Restrooms (sf)	\$	292,500	\$	292,500	\$	292,500	450
ATO & Airline Operations (sf)	\$	567,000	\$	567,000	\$	567,000	450
Outbound Bag Screening (sf)	\$	2,925,000	\$	2,925,000	\$	2,925,000	450
Equipment Allowance	\$	500,000	\$	500,000	\$	500,000	
Total Departure Processing (sf)		6,030,493		5,971,519		5,955,496	
Security Screening							
Passenger Screening Area (sf)	\$	1,307,029	\$	1,220,659	\$	1,197,194	450
Passenger Queue Area (sf)	\$	236,510	\$	220,881	\$	216,635	450
TSA Offices/Support Space (sf)	\$	450,000	\$	450,000	\$	450,000	450
Equipment Allowance	\$	750,000	\$	750,000	\$	750,000	
Total Security Screening	\$	2,743,539	\$	2,641,540	\$	2,613,829	
Gate Holdroom Facilities							
Passenger Holdroom (sf)	\$	1,630,973	\$	1,523,196	\$	1,493,916	450
Circulation (sf)	\$	326,195	\$	304,639	\$	298,783	450
Podium - queuing - exit corridor	\$	540,000	\$	540,000	\$	540,000	450
Restrooms (sf)	\$	270,000	\$	270,000	\$	270,000	450
Equipment Allowance	\$	100,000	\$	100,000	\$	100,000	
Total Gate Holdroom	\$	2,867,167	\$	2,737,835	\$	2,702,699	
Concessions and Services							
Food Concessions (sf)	\$	1,125,000	\$	1,125,000	\$	1,125,000	450
Vending Machines (sf)	\$	90,000	\$	90,000	\$	90,000	450
Total Concessions and Services	\$	1,215,000	\$	1,215,000	\$	1,215,000	
Arrivals Processing							
Waiting Lobby/Greeters Area (sf)	\$	649,220	\$	606,319	\$	594,663	450
Inbound Baggage Ops (non-public) (sf)	\$	1,125,000	\$	1,125,000	\$	1,125,000	450
Baggage Claim Lobby (sf)	\$	2,660,737	\$	2,484,913	\$	2,437,145	450

Passenger Terminal Cost Assumptions

Equipment Allowance	\$	250,000	\$	250,000	\$	250,000	
Total Arrivals Processing	\$	4,684,957	\$	4,466,231	\$	4,406,808	
Car Rental Facilities							
Car Rental Counters Area (sf)	\$	180,000	\$	180,000	\$	180,000	450
Car Rental Offices (sf)	\$	180,000	\$	180,000	\$	180,000	450
Queuing Area (sf)	\$	27,000	\$	27,000	\$	27,000	450
Total Car Rental Facilities	\$	387,000	\$	387,000	\$	387,000	
Airport Administration and Maintenance							
Airport Offices (sf)	\$	225,000	\$	225,000	\$	225,000	450
Loading Dock and Dumpster (sf)*	\$	90,000	\$	90,000	\$	90,000	450
Total Admin and Storage	\$	315,000	\$	315,000	\$	315,000	
Area Subtotal (sf):							
Mechanical/Electrical/Telecomm. (+ 10%)	\$	1,664,316	\$	1,613,413	\$	1,599,583	450
Building Support and Storage (10%)	\$	1,664,316	\$	1,613,413	\$	1,599,583	450
General Circulation (+ 15%)	\$	2,496,473	\$	2,420,119	\$	2,399,375	450
Building Structure (+ 3%)	\$	499,295	\$	484,024	\$	479,875	450
Total	\$	6,324,399	\$	6,130,968	\$	6,078,416	
Total Passenger Terminal Area (sf):							
Construction	\$	24,567,554	\$	23,865,093	\$	23,674,248	
Design	\$	1,965,404	\$	1,909,207	\$	1,893,940	
Other	\$	3,979,944	\$	3,866,145	\$	3,835,228	
Sales Tax	\$	2,898,726	\$	2,889,943	\$	2,566,918	
Total Passenger Terminal Building	\$	33,411,628	\$	32,530,389	\$	31,970,335	
Aircraft Parking	\$	959,473	\$	961,664	\$	949,572	
Auto Parking	\$	3,871,512	\$	5,818,835	\$	5,745,669	
Total Project	\$	38,242,613	\$	39,310,888	\$	38,665,575	

Aircraft Apron and Automobile Parking Assumptions

	Sonoma County		Buchanan		Travis	
Aircraft Apron						
Peak Hour Operations	4		4		4	
Critical/Design Aircraft	Q-400/CRJ		Q-400/CRJ		Q-400/CRJ	
Pavements	8,300		8,300		8,300	
Pavement Cost	\$	705,500	\$	705,500	\$	705,500
Design	\$	56,440	\$	56,440	\$	56,440
Other	\$	114,291	\$	114,291	\$	114,291
Sales Taxes	\$	83,242	\$	85,433	\$	73,341
Total Pavement	\$	959,473	\$	961,664	\$	949,572
Auto Parking						
Public	754		1,900		1,900	
Rental Car	1,350		1,350		1,350	
Employee	190		190		190	
Total Spaces	2,294		3,440		3,440	
Area Sy	57,350		86,000		86,000	
Cost	\$	2,867,500	\$	4,300,000	\$	4,300,000
Design	\$	229,400	\$	344,000	\$	344,000
Other	\$	438,728	\$	657,900	\$	657,900
Sales Taxes	\$	335,885	\$	516,935	\$	443,769
Total Pavement	\$	3,871,512	\$	5,818,835	\$	5,745,669